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SANITIZED VERSION OF FOLDER OF INFORMATION CONTAINING AIR MONITORING HISTORICAL INFORMATION (1953-1963)

(SANITIZED VERSION OF UNNUMBERED CRD DOCUMENT)

Compiled by
S. G. Thornton
Environmental Management Division
OAK RIDGE K-25 SITE
for the Health Studies Agreement

May 28, 1996

Oak Ridge K-25 Site
Oak Ridge, Tennessee 37831-7314
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the U.S. DEPARTMENT OF ENERGY
under Contract DE-AC05-84OR21400

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Technical Information Officer Oak Ridge K-25 Site

FOLDER OF INFORMATION CONTAINING AIR MONITORING HISTORICAL INFORMATION (1953-1963)

A. F. Becher, C. S. Williams, et al.

THE FOLLOWING ARTICLES/PUBLICATIONS WERE REMOVED FROM THE ORIGINAL DOCUMENT DUE TO COPYRIGHT RESTRICTIONS:

1. Newspaper clipping entitled "Continuous Alpha Air Monitor Has Been Designed at ORGDP," no author or newspaper given (it is believed that this article was from a 1958-1959 company newspaper; however, a search for the article in company newspapers was unsuccessful)

2 Pgs 3+4

INTER-COMPANY CORRESPONDENCE

Post Office Box P (INSERT) COMPANY CARBIDE AND CARBON CHEMICALS COMPANY LOCATION OAK RIDGE, TENN.

Dr. H. F. Henry

K-1001

DATE

April 22, 1953

LOCATION

TO

ANSWERING LETTER DATE

ATTENTION COPY TO

Mr. S. L. Sullins

File-

SUBJECT

Comparison of K-25 and Y-12

Air Sampling Equipment and

Techniques

Attached, hereto, are data obtained as a result of field tests made with the Gast, Hi Velocity, and Tornado air sampling units. Our findings and conclusions in connection with these tests are summarized below:

A. Preparation of the Equipment

- 1. In all cases, the equipment used had been calibrated for air flow and inspected for defects. They were concluded to be in good condition.
- 2. The Gast sampler employs a smaller collection head and is calibrated to collect sample at the normal breathing rate of man (approximately .75 cfm). Thus, not only a smaller size filter paper is employed, but a much smaller sample is obtained as compared with the 2 blower types which sample at the rate of 5 and 11 cfm. The Laboratory was advised of this and, as a result, they agreed to fabricate a new plate for the sample and increase the counting time.
- The smaller filter paper used at Y-12 was a Hollingsworth-Voss paper and, since some difference in collection efficiency as compared to the Whatman 41 might have been expected, tests were run with both types; the results did not indicate any appreciable difference.

B. Sampling Technique

- Tests were made on plant jobs in the K-1131 Building. Samples were taken under the conventional K-25 method using the Tornado at varying levels (generally, at floor level or slightly above); the Hi Velocity at face level in proximity to the operation, and a breathing some sample held as close as practicable to the operator during the job under consideration. In:addition, the respirator filters used by the operator were changed for each job surveyed and used as a check against the breathing zone samples.
- 2. On each job, except where specifically noted, a Gast type sampler was rum in parallel to the Tornado and Hi Velocity samplers for comparative purposes.

3. Since a considerable difference was noted in results obtained on the first 8 jobs, 6 additional tests were made wherein the Gast, Tornado, and Hi Velocity samplers were set up in parallel and exposed first to background and later to operating conditions in K-1131, with field conditions set up to simulate as near as possible comparable conditions for each sampler.

C. Findings

- 1. Initially, the laboratory results indicated the Gast samples obtained under seemingly comparable conditions were high by a factor varying from 3-9 (jobs 1-8).
- 2. Additional tests, under controlled conditions (jobs 9-14), reflected a consistent bias by which the Y-12 (Gest) sample was higher by a factor of 7.
- 5. Each of the sampler units were submitted to the Instrument Department for calibration check. In spite of the makeshift (poor) calibration methods used, in each case, the difference in assumed flow to measured flow was negligible; the Tornado, however, could not be checked against its original condition since it had been damaged in the shop and repaired before calibration.
- 4. Counting techniques were reviewed and an independent count made by the Health Physics Section on samples which were later delivered to the Laboratory Group. A considerable difference was noted in these results and subsequent investigation revealed the Laboratory Counting Section had neglected to make up a new plate for the small samples and were using the large disc to which the smaller samples were taped. The disc was found to be contaminated slightly which did not appreciably affect the large sample but produced an extremely high reading on the small samples, since most of the plate was exposed during this counting, and the sample amount being measured was infinitely smaller.
- 5. The blower type of sampler was dismantled and examined. Poor workmanship and maintenance were evidenced throughout in the bearing surfaces at connection points, orifice connection and mounting bolts. Poor control of inleakage, pressure indicator calibration, paper holder, and the use of a small appliance—type motor which fluctuates widely under load conditions were found.
- 6. On the comparative tests (9-14), the data collected reveals the Gast sample counts in 83% of the total sampled were higher by an average factor of 1.335. The average count on all samples was 1.732 c/m/ft³, while the average of the Gast samples was 1.753 c/m/ft³.
- 7. The variance from the respective averages was computed for each sampler on the 5 controlled samples with findings as follow: Gast variance 0.378, Hi Velocity 0.581, and the Tornado 4.136. The high variance in the Tornado results was attributable to one abnormally high result; the elimination of this one reading gave a variance of 0.0749 for the Tornado.

8. A comparison of sampling technique revealed the following:

a. Floor level samples b. Off floor level samples c. Face level samples - (Hi Velocity Only) - Average
d. Breathing Zone samples (Cast Only) e. Respirator samples Average
Average
3.34.80 c/m/ft

The face level samples were higher on 67% of the samples taken by an average factor of 6.166, as compared to the floor and off floor levels.

g. The breathing zone samples were higher in all cases by an average factor of 3.14, as compared to the Gast samples secured at face level.

h. The respirator samples were higher in every case where they were obtained by an average factor of 4.91, as compared to face level results, and higher by a factor of 1.38 in 50% of the cases, as compared to the breathing zone samples; conversely, the breathing zone average factor of difference compared to the respirator sample was 0.981, indicating fair correlation between the two.

Comclusions

1. The blower type of sampler has the advantage of compactness and portability, as well as providing a sample which can be counted more rapidly, thus reducing cost/sample obtained. Its reliability is questionable as evidenced in its variance; this is occasioned in part by design features where leakage occurs between the sample and calibrated orifice, paper holder, and motor characteristics. The calibration of flow during sampling requires close observation and calibration by the Instrument Department is not only poor but expensive as well.

This equipment should be modified to provide accurate calibration and insure positive support for the filter paper; repairs should be made to minimize inleakage.

2. The Gast type sampler has the advantage of accuracy in measuring flow, is readily calibrated, and provides a means for obtaining sample at varied levels with a minimum of effort. It is heavy and clumsy to use in congested areas, is not readily portable, and the use of a small paper with low flow rates increases counting costs.

The purchase of 3 units has been recommended, and it is planned to modify them wherein the pump and motor assembly will be portable and the collection head, arm and associated apparatus be placed at strategic locations for routine use.

- 3. Areas of suspected high air activity will be re-surveyed using varied levels of collection, as well as breathing zone and respirator samples to re-evaluate environmental conditions.
- 4. A wet and dry rotometer and necessary manifolding should be provided and a small work area established for routine check and minor adjustment of the equipment.

A. F. Becher Safety and Health Physics

AFBmap

MEMORANDUM

To:

Mr. A. F. Becher

Subject: Summary of Comparative Air Sampling Data

I. Data Concerning Types of Samplers

Three different types of air samplers, the Gast (Y-12), Tornado, and Hi-Velocity, were run simultaneously in the same location with sampler heads in same direction in order to test the collection efficiency of each type. Summary of data collected reveals that the Gast sampler consistently had higher counts. On 33 1/3% of the samples taken, the Gast counts were higher by an average factor of 1.335. The average count of all samples taken was 1.732 cts/min.ft³, while the average Gast count was 1.753. Highest and lowest counts were 2.96 and 0.76 respectively, the average of these two counts being 1.86 cts/min/ft³.

II. Data Concerning Sampling Levels

Air samples were taken at face level, off-floor, and floor level locations to determine what effect, if any, the location of the sampler had on the collection efficiency. Data collected reveals that face-level samples were higher on of of all samples taken by an average factor of 6.166.

The average face-level count was 79.22 cts/min/ft³ while the average off-floor and floor-level counts were 9.03 cts/min/ft³ and 24.998 cts/min/ft³ respectively.

III. Data Sheet

A data sheet, which lists all data taken and results from same, is attached to the original of this memorandum.

CSM: Vr

C. S. Williams for Safety and Radiation dazards

March 13, 1953

CONTINUOUS ALPHA AIR MONITOR DESIGNED AT URGDP

The original air sampling units, used in the field, were composed of a variety of pumps and blowers designed to pull an air sample through various types of filtering media. These original units sampled at a wide range of verocities and air flows, with some designed for high air volumes at short sampling intervals, and others for long-term or shift-length sampling at low volumes of air. Accuracies were generally limited by the flow characteristics of the pump or blower units under load or long-term use; however, there gradually evolved more reliable constant flow pump units which could be equipped with necessary controls and flow meters to compensate for change in flow. Despite these improvements, they had to be loaded and unicaded manually and care had to be exercised in handling the individual samples which were delivered to the Works Laboratory Counting Facility. Here again, each sample must be rehandled in loading, the laboratory instruments for counting of the sample. The total sample activity results obtained were recorded and returned to the operating group who then calculated the flow per unit volume of air sampled. At the CREEDP this is usually expressed in terms of alpha counts/minute/ft.3 of air sampled.

During the latter part of 1954, J. C. Bailey and A. F. Becher of the Cafety, Fire, and Radiation Control Department were able to assemble, from a variety of used components, an instrument which they referred to as a continuous alpha air monitor. This unit would automatically collect an air sample, and four hours later count the residual uranium alpha activity which may have been collected on the moving belt-type filter paper; this activity being detected by a scintillation detection tube which, in turn, fed its pulses through an electronic scaling unit. The final results were recorded on a traffic counting-type register which stamped and cleared at thirty-minute intervals.

The instrument was successfully tested on the prant during 1955 and, in October of that year, design was initiated to provide for two shop-fabricated units. These units were also field tested and improvements were added to increase the efficiency as well as to more adequately assure continuous operation. ... contract was ret during 1956 for fabrication of eight of these modified units and, by January 1958, orders had been praced for an additional ten such instruments.

These improved units are now available commercially and have been advertised or shown at several nationally famous conventions.

A total of 20 of these alpha air monitors are now installed throughout the plant. Each monitor consists of a special filter paper strip-driving mechanism assembled together with a vacuum pump, a scintillation detector, an electronic scaling unit, and two recording registers mounted on a two-shelf, castor-equipped table.

The vacuum pump draws air into the instrument through the filter paper which collects entrained dust particles. At the end of a thirty-minute collection period the pump is automatically cut off and the continuous roll of filter paper is indexed to its next sampling position. Auccessive collection and indexing gradually moves the air sample on the filter paper from the collection point to the scintillation counter. Mine indexes are required from the sample point to the counter. Thus, a complete cycle for a sample consists of a thirty-minute collection period, eight indexing positions which yield a four-hour decay period, and a thirty-minute counting period; thus, the total time lapse between start of a sampling interval and the registered count is five hours.

The scaling unit counts the pulses from the detector and sends an impulse to the registers every sixteenth count. The half-hour register totals these impulses over the thirty-minute interval, prints the numerical

sum on a paper tape, and clears at the conclusion of each period. The eight-hour register is arranged to total every 255th pulse from the detector over an eight-hour interval, and it too, prints and clears at the end of its eight-hour period. Thus, the total that this latter unit prints gives the average count obtained on the half-hour register during the preceding eight-hour period.

A.F.Becherila

February 5, 1959

CASCADE IMPACTOR

Daterence: Pharmacology & Text Select of Branium Compounds;

instructions for calculating reconstric standard deviation.

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History of Hir Sampling

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6.	Review of Air Contamunation & Winterior -	5/57
7.	Review of Air Contamunation & MiniToring -	11/57
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18.4. Jarbon Monoxide Petector (hand operated).

.S.A. Colorimetric Carbon : onoxide Detector.

".S.m. Tydrogen Sulfide Detector

.S.A. Clectrostatic Sampler

Sir-Sampling Equipment Co. Sutomatic Impinger

'.S.A. Midget Impinger Pump

.S.m. Wolf Safety Lamp

Davis Tapotester 1-6

Cavis Halide Meter

Davis Micro-Gas Analyzer

Continuous Analyzer for Airborne Fluorides

Alnor Velometer

Bausch & Lomb Dust Counter

G. E. Instantaneous Vapor Detector

Gast Air Sampling Pump, Model 0210-V36-10X

A.I.S.I. Smoke and Fume Sampler

Hastings Hodel G. Air Meter

Thomas Autometer

TYSCHITTION

TOYOLOTECH INSTRUMENTED FOR LUDGE THE GOLD HE. Described in Jection I, pp.146-151.

Ibid. Section I, pp.151-153.

_bid. Section I, pp.168-169.

Toid. Section I, pp. 159-160.

-bid. Section 1, pp. 63-64

Ibid. Section I, pp. 170-172.

Did. Section I, ap. 177-179.

Ibid. Section 1, pp. 37-39.

-bid. Section I, pp. 79-82.

Thid. Portable version of that described in Section I, pp. 77-79.

Does not include recorder.

This instrument, still under development at the OFMOP, samples air at about 2 liters per minute and continuously records the concentration of fluorides in the sampled air. The principle is based on the fluoride sensitive electrolysis in a cell composed of an aluminum-platinum electrode pair in the presence of a solution containing fluorides.

Ibid. Section III, pp. 759-764.

Thid. Section I, pp. 68-71.

Ibid. Section I, pp. 113-116.

Ibid. Section I, pp. 109-110.

Ibid. Section III, op. 661-662.

Ibid. Section IV, p. 750. less accessories.

Ibid. Section II, pp. 256-257.

AIR SAMPLING DEVICES AT THE LAK CLOSE GASTOUS DIFFESTIM FLANT

AME

Freon Powered Fortable Air Sampler Kit

Beckman Oxygen Analyzer

Imperial Malide Leak Detector

1-9 Chemical Detector Kit

Hydrochloric Acid Detector

Ammonia Netector

*Press=0-Vac Vacuum Pump Sampler

High Volume Sampler (Staplex). Modified to use 9 cm. diameter filter.

1-1/8" Sampler with Gast Pump

Continuous Alpha Air Sampler-Counter-Recorder.

TESCRIPTION

Described in ENDUSTRIAL YOUNG QUARTERLY; Volume 12, No. 2, June 1057; pp. 135-138.

Arnold C. Reckman, Inc. South Pasadena, Calif. (Bulletin 105).

Using the modified Beilstein test for malides, air containing halogenated hydrocarbons is aspirated over a copper ring heated by a Prestolite flame. The copper-halides formed produce varying colors in the flame. These are semi-quantitative measures of the concentrations of the halocarbons present.

INDUSTRIAL AND EMGINEERING CHEMISTRY;

(Anal. Ed.) 11, pp. 121 & 250, (1939)

U. S. Army Chemical Corps. Qualitative test for various chemical agents, including phosgene and chlorine.

Air containing hydrochloric acid is aspirated by means of a 75 ml. hand pump through a dilute solution of sodium hydroxide containing a mixed acid-base indicator. The number of pump strokes required to neutralize the alkali is a measure of the concentration.

Same as the hydrochloric acid detector with a weak solution of the acid as the absorbing media.

Samples from 25-30 liters per min. using 1-1/8" diameter Whatman hi filter paper.

High Volume Air Sampler manufactured by Staplex Company. Samples 7-15 cfm. with 9 cm. diameter Whatman 41 filter paper.

Samples from 10-30 liters per minute using Whatman hl or Hillipore filter.

Neveloped by ORGBP; fabricated by
Huclear-Electronics Corp., 2632-36 West
Cumberland St., Philadelphia, Pa.
Samples 5-6 cfm. on continuous strip of
HRV filter paper 9 mils. thick, hm wide.
Sampling period 30 minutes, counting period,
after he hr. delay, 30 minutes; limit of
detection approximately 1 x 10-12 microcuries per ml. air. Recorders print
average airborne activity for 30-min. and
8-hour intervals.

YEL A WING DAMING A ART ARE THE SELECTION OF THE SELECTIO

87.0

"igh olume ampler (Staplex) with annular impactor.

Gooseneck Gampler with Gast Sump

.rogram Reset Relays

Timed-to-rum control Valves

Timed-to-run, Elapsed-Time Control Valves DE CREPTER

Impactor manufactured by;
F. F. Blocomp corporation
1h00 coplar St. Tilmination 77, Telaware.
Samples approximately 30cfm. with impactions of particles on 1." greased plastic lise.

Samples approximately 1-4 dim. using Whatman 11 filter paper 2 cm. diameter.

Program relay set to actuate 110 volt electrical powered sampling equipment up to 2h hours later and to shut down the same equipment after some set time interval.

Units consist of two 110 v. AC magnetically actuated valves, one for intake and one for exhaust, and a variable timer which may be set to run in units of 6 minutes through 2h hours. They may be used as a primary power source of electrical sampling equipment and/or un elapsed timer.

Units consist of two 110 volt AC magnetically actuated valves, one for the intake and one for exhaust, and a variable timer which may be set to run in units of 3 minutes up to 12 hours and will indicate actual elapsed time in minutes to the mearest tenth.

MINUTES OF MEETING TO DISCUSS AIR MONITORING NOVEMBER 5, 1957

Present: J. T. Dalton, J. R. Mahoney, and R. W. Schede of the Plant Engineering Division, H. A. Bernhardt of the Technical Division, and J. C. Bailey, A. F. Becher, and H. F. Henry of the Industrial Relations Division

GENERAL DISCUSSION

Since the control of air-borne alpha emitters is the major radiation safety problem at ORGDP, the development of an accurate, fast, automatic device for the monitoring and recording of the concentrations of airborne alpha emitters of significance has received continuing attention. The major difficulty encountered both here and at other installations with this problem is due to the naturally occurring radioactive daughter products of radon. Radon and thoron gases are released to the atmosphere from the earth's crust, and although the gases themselves are not collected by particulate samplers, the daughter products, being solid materials, are collected along with other particulates. These daughter products emit alpha, beta, and gamma radiations, but since the radon daughters have a half life of only 30 minutes and the thoron daughters a half life of only 11 hours, these emitters present no radiation health problem. However, the concentration of alpha-emitting radon daughters may vary by a factor of 5 to 10 within a single day, with an over-all variation by a factor of 22, these changes being related to meterological conditions; 1 in addition, peaks as high as 10 times the activity established as the maximum allowable concentration for uranium have been observed, 2 and the radon daughters therefore tend to obscure monitoring results for long-lived radioactive isotopes. On the other hand, the activity of thoron daughters in air is only about 3% of that associated with radon daughters, and hence the thoron daughters do not interfere appreciably with monitoring for air-borne uranium.

The practice at ORGDP since the initiation of an air-monitoring program in 1948 has been to delay the counting of air samples for at least 4 hours, this being a sufficient period to permit essentially all the naturally occurring alpha emitters in the sample to decay. Automatic monitors utilizing such a delay period have been developed at the ORGDP; these monitors are in limited use and the procurement of additional ones is in progress. However, the problems associated with the development of a suitable instrument which will discriminate against the radon daughter products and thus yield prompt information concerning uranium concentrations in the air, and which could accordingly be used both for normal monitoring and as a device to activate an alarm in the event of excessive concentrations of air-borne activity, have not yet been overcome.

¹ King, W. C., <u>Variations in the Natural Radioactivity of the Free Atmosphere at ORNL</u>, Oak Ridge National Laboratory, Oak Ridge, Tennessee, January 20, 1952, (ORNL-1277)

² King, W. C., <u>Meteorological Influences on the Natural Radon and Thoron Concentrations in the Free Atmosphere at Oak Ridge National Laboratory</u>, Thesis for Master's degree, Vanderbilt University, September, 1953

Since the efforts to provide a means for discriminating against radon daughters have to date been conducted on a more or less informal basis, it was considered appropriate that those groups most directly concerned with these developmental efforts review the progress attained and consider additional possible approaches to the problem.

At a preliminary meeting on July 10, 1957, representatives of the Plant Engineering, Technical, and Industrial Relations Divisions discussed briefly possible methods which might be considered; on November 5, 1957, these methods were considered somewhat more fully and the progress made in investigating some of the factors involved was discussed. The possibilities considered for effecting possible separation of uranium from radon daughter products are presented below along with comments concerning the feasibility of the methods as developed at one or both of the meetings.

The feasibility of using an alarm device which rapidly counts the gross alpha activity, but which will alarm only when this activity exceeds that which might be attributed to natural alpha emitters, was considered briefly. It was felt that such an instrument used in conjunction with the present type of monitoring and recording devices represented an alternative to the development of a single instrument which would both yield satisfactory monitoring results and serve as an alarm device.

SAMPLING METHODS CONSIDERED

- 1. Impactor samplers.
- 2. Use of a coarse filter paper followed by a fine filter paper in series.
- Precipitron (electrostatic precipitation),
- 4. Centrifuging.
- 5. Alpha-energy-discrimination.
- 6. Comparison of alpha and beta radiations.
- 7. Gamma spectroscopy.
- 8. Radon comparison from "clean" air.
- 9. Radon-daughter and uranium collection on filter paper, with comparison of radon gas passing the filter.
- 10. Colorimetric chemical methods.
- 11. Flocculation of uranium with chemical separation and counting.
- 12. Light transmission.

- 13. Electrical conductivity.
- 14. Sonic effects.
- 15. Burn-up of organic dusts with release of radon daughters.
- 16. Collection on a heated or cooled impaction surface.
- 17. Magnetic or electrical effects.
- 18. Humidification of sampled air stream.

DISCUSSION OF SAMPLING METHODS

A. Particle Diameter or Mass Discrimination

Studies at other installations have indicated that the radon daughters are deposited on natural dust particles and that 90% of these daughters are on particles with a diameter of less than 0.035 micron.³ "Industrial dusts" are reported to be primarily in the particle-size range of 1 micron or larger, and the use of samplers which will collect only the larger particles has been reported by other installations. However, studies at ORGDP, some of them devoted to preparing particles of varying dimensions, have indicated that the particle size of UO₂F₂ fumes resulting from UF₆ releases is highly variable, and that, in many cases, the particle sizes are in the same range as the dust particles upon which the radon daughters are deposited. In addition, one reference⁴ indicates a mass median particle size of 0.1 micron for such fumes.

Thus, collection methods which discriminate against radon daughters on the basis of particle size may not be generally applicable to all conditions at ORGDP, since any sampler which would satisfactorily collect UO₂F₂ fumes might also collect a large fraction of these radon daughters, and, conversely, any sampler which did not collect the radon daughters might not collect UO₂F₂ effectively. However, such devices would probably be satisfactory for monitoring for uranium dusts such as UF₄ and UO₃, and it was considered desirable to continue the investigation of particle-discrimination methods. Comments concerning possible methods were as follows:

1. <u>Impactors</u>

Developmental work on a continuous impactor sampler is in progress at ORGDP, and commercially available impactor samplers are also being evaluated. Impactor samplers similar to the commercially

3 Tait, G. W. C., <u>Determining Concentration of Air-Borne Plutonium Dust</u>, Nucleonics, Vol. 14, No. 1, January, 1956

⁴ Stevens, D. C., <u>Air Sampling With the Annular Impactor</u>, August 28, 1956, (A.E.R.E. HP/M 110), Great Britian Atomic Energy Research Establishment, Harwell, Berks, England

available ones are reported to collect essentially all particles I micron or more in diameter but only a small fraction of the particles with diameters less than 0.5 micron. However, such impactors are reported to have actually collected between 1% and 19% of the radon decay products in the air, indicating that the separation of particle sizes with available devices is not as sharp as would be desirable. However, it was felt that attention should continue to be given to impactors as possible sampling devices.

2. <u>Differential Collection on Filter Papers</u>

The use of a coarse filter paper to collect uranium particles and the larger dust particles, with a fine filter paper in series to collect the smaller dust particles to permit correction for the radon-daughter activity has received very little attention. This appears to represent a relatively simple method, and it was felt that some exploratory work was desirable.

3. <u>Precipitron (Electrostatic Precipitation)</u>

A literature study indicated that the precipitron probably would not be applicable since it collects preferentially the larger particles and the very fine particles, with intermediate size particles being collected with reduced efficiency.

B. Radiation Discrimination

1. Alpha-Energy-Discriminating Counter

Although the alpha energies associated with radon decay products are greater than those associated with uranium decay, satisfactory energy discrimination requires a source sufficiently thin that the alpha-particle energies are not degraded by passage through the sample. Since the sampled material, as well as atmospheric dust, would be present in appreciable quantities this method was not considered to be promising.

2. Comparison of Alpha and Beta Radiations

The presence of beta-emitting uranium daughter products in varying amounts in plant locations appears to preclude the use of the ratio of alpha to beta radiation from radon daughters as a means of discriminating against these daughters.

3. Gamma Spectroscopy

Although gamma rays of low energy have been reported to be emitted from all three of the natural uranium isotopes, the difficulties of gamma spectroscopy instrumentation, the complication of the presence of a wide range of gamma energies from other isotopes, and the paucity of information concerning the gamma emission from the uranium isotopes appears to preclude the use of a method based

on gamma spectroscopy within the foreseeable future.

4. Radon Comparison From "Clean" Air

The use of a central monitor to measure the natural radioactivity in the air, with the results being used to correct the results of field monitors appeared to be possible, although there was some question as to the relationship between the radon activity in air taken from outdoors and that in air taken inside a closed building; especially would this be a problem where the air change inside a building is infrequent.

C. Other Physical or Chemical Effects

While colorimetric chemical methods, chemical separation, and conductivity could probably be adapted to uranium detection, these processes do not lend themselves to the rapid determination of results; in addition, methods for determining the mass of uranium would not indicate uranium activity, since the activity depends not only upon the quantity of uranium present but also upon the assay.

D. Possible Conditions Which Might Effect a Differential Collection of Uranium and Radon Decay Products

Some factors which were considered to represent possible means for altering the differential collection efficiencies for uranium compounds, particularly UO_2F_2 , and radon decay products were the agglomeration of UO_2F_2 by sonic effects or the humidification of the sampled gas stream, the burn-up of organic dusts with release of radon daughters, and collection on a heated or cooled impaction surface.

The applicability of centrifuging, detection of radon passing a filter, and light transmission were not discussed.

PROPOSED INVESTIGATION

It was considered desirable that the Instrument and Machine Engineering Department continue to take the lead in the investigation of suitable methods for prompt detection of air-borne uranium, and, since many of the methods considered involve knowledge of particle sizes of air-borne uranium materials in the plant, it was agreed that this department would continue an investigation of this question. It was also agreed that studies with 2 filter papers in series would be conducted along with the particle-size measurements; Mr. J. C. Bailey was requested to assist in the selection of suitable filter papers.

It was also felt desirable to do some exploratory work in connection with the use of heated or cooled impaction surfaces and the effects of

humidifying the sampled gas stream. Dr. H. A. Bernhardt agreed to work with the Instrument and Machine Engineering Department in developing these studies.

Mr. A. F. Becher was requested to review available air-sampling data to evaluate possible information concerning materials and locations which represent the major plant problems.

J.C.Bailey:lja

11-19-57

cc: Those present

Mr. K. W. Bahler

Mr. R. M. Batch

Mr. E C. Bollinger Mr. D. M. Lang

Mr. W. L. Richardson

Mr. M. F. Schwenn

Mr. H. G. P. Snyder

File - RC

H. F. Henry
Safety, Fire, and Radiation Control

and Droft

OAK RIDGE GASEOUS DIFFUSION PLANT

SPOT AIR SAMPLES - 1955 - 1956 - 1957* ("through March)

Location	Sampling Program Status
Vault 1-I	Continuing
Vanit 8-A	Continuing
Vanit 15-A	Centiming
Venit 16-A	Continuing
Vanit 16-A Office	Continuing
Venit 17-A	Contiming
E-27 Booster Stations	Continuing
K-27 LaRa and SaRa Pomps	Continuing ·
15-33 Feed Room	Continuing
E-33 Section Alumina Traps	Continuing
K-33 Cooling Tower - Special	Sempling done as needed for problem evaluation
E-101. Building	Continuing
K-131 Chemical Meintenance Shop	Continuing
K-131 Feed Building	Contiming
E-131 Solutions Recovery	Miscontinued - building in stand-by
E-132 Solutions Recovery	Miscontinued - building in stand-by
K-301-is Instrument Shop	Continuing
1-301-is Instrument Shop Office	Continuing
K-301-5 & K-302-1 Withdrawal Alley Job Audite	Sampling done as needed for job evaluation
E-302-1 Test Loop	Continuing
K-302-1 Welding Shop	Continuing
E-302-5 Cold Trup Room	Continuing
K-302-5 Process Haintenance Shop	Continuing
K-303-1 Cylinder Shop	Continuing
K-303-1 Seal Shop	Continuing
E-303-6 Process Lab	Continuing 23

Location	Sampling Program Status
K-303-3 & K-303-4 Withdrawal Alley Job Audits	Sampling done as needed for job evaluation
K-303-6 Field Lab	Included with K-303-6 Process Lab
K-304-2 Promp Change Job Audit	Sampling done as needed for job evaluation
K-30k-3 Impeller Change Job Audit	Sampling done as needed for job evaluation
K-305-9 Instrument Shop	Continuing
K-305-12 Process Heintenance Shop	Continuing
K-306-7 Field Lab	Continuing
K-306-7 P. W. Station	Continuing
E-306-7 Nedgh Room	Continuing
K-309-3 Test Loop	Continuing
E-312 Section Alumina Traps	Continuing
E-312-1 & 3 Alumina Trap Job Audit	Sampling done as needed for job evaluation
E-312-1 Basement	Continuing
K-312-2 Besement	Continuing
E-312-2 Process Haintenance Shop	Continuing
K-312-3 Basement	Continuing
1-402-5 Pump Dismontling	Continuing
E-413 Building	Contiming
E-113 Chemical Meintenance Shop	Continuing
E-613 Electrical Shop	Continuing
K-113 Instrument Shop	Discontinued - Ametion moved
K-133 Process Maintenance Office and L. R.	Temporarily discontinued - no air problem indicated
E-601 Sampling	Continuing
K-631 Waste Misposel	Continuing
K-902 Comp. and Conv. Change Job Audit	Sampling done as needed for job evaluation

Location	Sampling Program Status
E-902-7 Cell 3 Job Audit	Sampling done as needed for job evaluation
K-1004-A Sampling	Continuing
K-1004-B Laboratory - Special	Sampling done as needed for problem evaluation
K-100k-B Uranium Analysis - Special	Sampling done as needed for problem evaluation
K-100k-J Flutonium Analysis	Continuing
K-100k-J Radiochemical Lab	Contiming
E-1024 Acid Room and Valve Repair	Continuing
E-1024 Instrument Shop	Contiming
K-1025 Feed Storage Building	Continuing
E-1030 Electrical Shop	Contiming
16-1031. Storage	Continuing
16-1037 Helter Area	Continuing
E-1131 Barrier Filter Change Job Andit	Sampling done as needed for job avaluation
E-3131 Red Production Area	Continuing.
E-1131 Offices and Facilities	Continuing
K-1131 Process Laboratory	Continuing
E-1219 Building	Continuing
_ 	

1-1301 Oride Conversion
E-1303 Building
K-1303 Chemical Maintenance Shop
K-1101 A.F. Comp. and A.C. Pump Shop
K-1101 Cleaning and Preparation Area
K-11:01 Cleaning Area Job Audits

Continuing

Discontinued - function moved to K-1420

Discontinued - function moved

Contiming

Continuing

Sampling done as needed for job evaluation

Location	Sampling Program Status		
K-1101 Compressor Decontamination	Discontinued - function moved to K-1120		
K-1401 Compressor Decentsmination Job Audits	Discontinued - function moved to K-1120		
K-1101 Converter Assembly and Retubing	Continuing - included with K-11:01 Cleaning and Preparation Area		
K-3101 Converter Scarfing	Continuing - included with K-1401 Cleaning and Preparation Area		
Kelifil Cooler Assembly Area Job Audits	Sampling done as needed for job evaluation		
K-11:01 Cooler Repair Shop Job Audits	Sampling done as needed for job evaluation		
K-lim Electrical Shop	Temporarily discontinued - no air problem indicated		
K-1101 Ferrule Removal Area	Discontinued - function moved to K-1420		
E-1101 Machine Shop Job Audit	Sampling done as needed for job evaluation		
E-11(II) Nachine Shop - Special	Sampling done as needed for problem evaluation		
E-3101 Preparation Area Job Audit	Sampling done as needed for job evaluation		
K-lkOl Spool Modification - Special	Sampling done as needed for problem evaluation		
E-1101 Speci Modification Job Audit	Sampling done as needed for job evaluation		
E-1101 Speel Modification F-Bay	Contiming		
K-1101 Vacuum Pump Shop	Continuing		
K-liffi Valve Shop	Continuing		
K-1010 Barrier Filter Disassembly Job Audit	Sampling done as needed for job evaluation		
K-1/10 Decontemination	Continuing		
K-1/10 Office, Locker, and Lunch Room	Continuing		
E-1413 Building	Continuing		
K-1113 Design and Development - Special.	Sampling done as needed for problem evaluatio		
K-1113 Utility Maintenance Shop	Continuing		
K-1420 Building	Continuing		
K-1120 Chemical Haintenance Shop	Continuing		

Location	Sampling Program Status		
K-11/20 Converter Detailing Job Audit	Sampling done as needed for job evaluation		
K-1420 Deferraling Booth	Continuing		
K-11:20 Klectrical Shop	Continuing		
K-11:20 Large Equipment Decontamination	Continuing		
K-11/20 Process Lab	Temporarily discontinued - no air problem indicated		
K-1120 Recovery	Continuing		
K-1420 Small Parts Decontamination	Continuing		
E-11/21 Incinerator Building	Continuing		
M-1121 Incinerator Job Audit	Sampling done as needed for job evaluation		
	1		

Note: Spot air samples are taken where it is most probable that operational processes and procedures, equipment and building maintenance operations, or surface contamination levels are such that radioactive contaminants might be introduced into the environmental air of work areas.

SAKtero

5-14-57

OAK RIEGE GASEOUS DIFFUSION FLANT

LONG-TERM AIR SAMPLING - 1955 - 1956 - 1957* (*through March)

Location	Sampling Program Status
K-113 Chemical Maintenance Shop K-1101 A.F. Comp. & A.C. Pump Shop	Continuing Discontinued - function requiring monitoring moved to K-1420
K-131 Solutions Recovery Building	Discontinued - function moved to K-1120
E-1037 Melter Area	Miscontinued - no air problem indicated
K-1131 Feed Production Area	Centiming
K-130% Oxide Conversion	Discontinued - operations terminated
E-1110 Decontamination	Discontinued - primary function moved to K-1120
K-11/20 Building	Continuing
5-33 Feed	Continuing
K-131 Feed Building	Discontinued - function transferred to K-33
Area III L.R. & S.E. Pumps	Continuing
K-306-7 P. W.	Continuing
K-601 Sampling	Continuing
K-631, Waste Disposal	Continuing
K-1413 Building	Continuing
K-11:01 Preparation Area	Discontinued - no air problem indicated

SAKtero

5-14-57

LOCATIONS WHERE RESPIRATORY PROTECTIVE DEVICES ARE REQUIRED AT CREDP

Mandatory by Area

Respiratory protection required for all persons at all times in the following locations:

K-1131 Feed Production - Drum Dumper Area

K-3131 Feed Production - Pit Area

K-1131 Feed Production - Screener Room

K-1131 Feed Production - UO3 Platform

K-1231 Uranium Pulveriser Area

Mandatory by Job

Respiratory protection required for all persons in the affected area while systems are open or until the job listed is completed if air contamination is probable.

All Cascade Buildings, Process Buildings, and Pilot Flants - Equipment or system changes involving work on open equipment, piping, etc., which has contained toxic, corresive, or radioactive materials

. Alumina Trap Facilities - Trap change and decentamination

Vanlt 16-A Material Storage - Material transfer and sampling

K-33 Feed - Sampling and connecting and disconnecting cylinders

K-101 Coolant Recovery - Withdrawal of coolant

K-306-7 Product Withdrawal - Commecting and disconnecting cylinders

K-413 Feed Production Maintenance Shops - Feed production equipment dismantling and repair

K-601 Sampling - Commecting and disconnecting cylinders

K-631 Waste Disposal - Connecting and disconnecting cylinders to manifold

K-102h Instrument Shop - Equipment decontamination

K-1037 Melter Area - Converter shall repair

K-1131 Feed Production - Sampling and equipment maintenance

Locations Where Respiratory Protective Devices are Required at ORCEP Page 2

Mandatory by Job (Contid)

- K-1300 Area Fluorins generator repair
- K-1401 Equipment Repair Shops Valve, motor, and pump and impeller repair
- K-11:10 Equipment Decontamination Disassembly and decontamination of barrier filters, ash receivers, towers, etc.
- K-1113 Design and Development Sampling, powder handling, equipment maintenance, and routine equipment cleaning
- K-1120 Equipment Decontamination Compressor, converter, and spool dismantling and decontamination small parts disassembly and decontamination
- K-1120 Material Recovery Material processing
- K-1/21 Incinerator Burning of contaminated materials

SAKterc

5-16-57

MEETING TO REVIEW AIR CONTAMINATION AND MONITORING ACTIVITIES

Times May 1, 1957, 2:00 p.m., Room B-244, K-1001 Building

Attendance:

K. M. Jones, Production Division; J. W. Arendt, Process Engineering Division; E. C. Bollinger, and B. H. Thompson, Chemical Division; M. B. Herskovitz, T. J. Lewis, J. R. Mahoney, R. W. Schede, and W. C. Warram, Plant Engineering Division; H. F. Henry, and W. L. Richardson, Industrial Relations Division.

Representatives of the operating divisions having the principal problems of uranium air contamination met with engineering and staff health physics organizations to review data concerning the adequacy of the present control and monitoring programs associated with these problems.

Data obtained in the staff health physics air monitoring program for the years 1955, 1956, and the first quarter of 1957 were briefly reviewed by Dr. Henry, and the attachments summarize the information presented. From these, it was noted that continuous long-term sampling is carried on in all locations where the probability of serious air contamination problems exist with an average of approximately 900-1000 shift-length samples being obtained monthly, and that the average air activity in these locations has remained at about 10% of the P.A.L. of 1 c./min./ft.3. It was pointed out that these results could be high as compared with the average air breathed by personnel, since they included those samples which were in progress at the time of any material releases in the locations involved which could result in comparatively high air activities, and during which any employees working therein would normally be wearing respiratory protection; in addition it was noted that, although these results probably give a good picture of the average air activity in their vicinity and thus in the locations concerned, they obviously are indicative only as far as the actual air breathed by any one individual would be concerned.

In reviewing these data, it was the opinion of the group that the average air activity in these locations was not such as to indicate a problem and that the monitoring program was adequate. However, it was also recognized that no record of the results of short-term sampling as performed by operating groups was so maintained as to form a part of the official plant record of air contamination, and the group thus recommended that the various groups concerned make arrangements to forward copies of the results of their air samples to the Safety, Fire, and Radiation Control Department as is now done with their routine surface contamination checks. It was also noted that arrangements should be made to be sure that the air levels for those jobs where air contamination is a possibility, such as those involving the opening of process systems, are periodically rechecked, especially in those cases where the equipment or methods used are altered.

A partial list of jobs requiring respiratory protection as prepared by the health physics group was also briefly reviewed, and representatives of the operating organizations present indicated that they would review operations with a view to completing this list. It was also noted that the use of respiratory protection

has been considerably stepped up as a result of the emphasis placed upon its importance last year, and it was the opinion of the committee that general compliance with plant requirements for such usage was good; otherwise, it was considered probable that more positive urinary uranium results would result.

In a review of the general problem of hazards due to the radioactive properties of uranium, it was again noted that although surface contamination, as such, presented no particular problem except as it could become air-borne, it did present a convenient method for determining where there was a possibility of air-borne contamination, and, if it reached levels previously determined, it could actually present an air-borne problem.

Mr. Arendt and Mr. Jones stated that they felt more sampling should be performed by the operating groups, but that trouble had been encountered with the Staplex Hi-Vol sampler "burning up." According to Mr. Mahoney, this might be expected if the Staplex sampler were used for continuous work instead of short-term sampling, and he agreed to test some Staplex samplers to determine the actual cause of the "burn-up" and if any simple precautions could be taken in the future to prevent it.

The other types of samplers currently in use in the plant were briefly mentioned. In addition to the Staplex unit, which is basically most useful for short-term monitoring, these included the types of units used for long-term sampling and powered by a Cenco vacuum pump and a Gast vacuum pump, respectively; the latter uses a much lower air flow and smaller filter paper than the former. One disadvantage of all of these samplers, as was pointed out, was the necessity for a comparatively long wait to obtain useful data concerning the air activity with the result that the information thus obtained was useful primarily for record purposes. Accordingly, an impactor-type head which could be used with the Staplex sampler was briefly demonstrated as one of the efforts being made to meet this objection. Several of these heads are now available, and plans are under way for their calibration which should be completed within the next 3 months.

Other projected air samplers were also briefly reviewed. These included the preliminary model now in plant use which samples and prints the average air activity at half-hour intervals with the counting being performed at the machine same 5 hours after the sample is taken to permit the dying out of radon and thoron alpha-active daughters. In addition, the 2 similar prototype samplers which have just been completed at the ORGDP to perform the same function were mentioned as well as the fact that they are currently undergoing field tests and should be available for general plant use in a few weeks. Pictures of these 2 prototypes were made available by the engineering groups, and it was noted that 8 similar units are now being purchased with delivery expected in June.

The engineering groups also discussed the status of development activities with a continuous sampler using the impaction principle which will permit prompt measurement and recording of air activity and which can be fitted with high-level alarms which were considered very desirable by the operating groups. It was indicated that this instrument should be ready for field testing and checking in about 6 months. The possibility of obtaining any of these instruments from commercial sources was considered very slight except on a

special contract such as that under which the 8 units on order are being procured.

The consensus of the group was that present monitoring and control of the alpha air activity in the plant was probably adequate but that it would be desirable for operations personnel to perform more air monitoring, especially on specific jobs, and forward the data to the staff groups concerned. Continuation of the development and testing of the air monitors available and proposed was also considered desirable. With respect to plant personnel, the problem seems to be that of all safety-type activities in seeing that employees are aware of the hazards and take adequate protective steps against them.

HFH:1ja

Attachments: ORGDP Air Activity - 1955 - 1956 - 1957

(Through March) - 5-17-57

ORGDP Long-Term Air Sampling - 1955 - 1956 - 1957

(Through March) - 5-17-57

ORGDP Short-Term Air Samples - 1955 - 1956 - 1957

(Through March) -5-17-57

Locations Where Respiratory Protective Devices

are Required at ORGDP - 5-17-57

c.c. Those Present

Mr. K. W. Bahler

: Mr. A. P. Huber

Mr. D. M. Lang

Mr. J. A. Marshall

Mr. J. A. Parsons

Mr. M. F. Schwenn

Mr. H. G. P. Snyder

No RC

OAK RIDGE GASEOUS DIFFUSION PLANT

AIR ACTIVITY - 1955 - 1956 - 1957 (THROUGH MARCH)

1. Long-Term Air Activity (Shift Length)

Quarter	# Samples	# Samples > P.A.L.	% Samples > P.A.L.	Average Activity
Jan-Mar, 1955	1409	31	2.2%	0.17
Apr-Jun, 1955	1885	19	1.0%	0.34
Jul-Sep, 1955	1569	7	4.5%	0.03
Oct-Dec, 1955	2131	45	2.1%	0.12
Jan-Mar, 1956	3016	51	1.7%	0.12
Apr-Jun, 1956	2816	61	2.1%	0.17
Jul-Sep, 1956	2610	214	0.9%	0.09
Oct-Dec, 1956	2689	33	1.2%	0.08
Jan-Mar, 1957	2633	21	0.8%	0.07

2. Short-Term Air Activity

Quarter	# Samples	# Samples > P.A.L.	% Samples > P.A.L.	Average Activity*
Jan-Mar, 1955	253	28	11.1%	0.77
Apr-Jun, 1955	234	10	4.3%	0.25
Jul-Sep, 1955	263	6	2.3%	0.13
Oct-Dec, 1955	228	12	5 .3%	0.46
Jan-Mar, 1956	205	24	11.7%	5.00
Apr-Jun, 1956	203	11	5.4%	0.45
Jul-Sep, 1956	187	9	4.8%	0.33
Oct-Dec, 1956	192	14	7.3%	2.00
Jan-Mar, 1957	206	14	6.8%	0.37

^{*} Results not considered especially significant since such sampling is frequently chosen to give the highest possible activity, and any employees involved wearing respiratory protection.

OAK RIDGE GASEOUS DIFFUSION PLANT

LONG-TERM AIR SAMPLING - 1955 - 1956 - 1957 (THROUGH MARCH)

Location	Sampling Points	Sampling Program Status
Area III Line Recorder and Seal Exhaust Pumps	1*	Continuing
K-33 Cascade Feed	1	Continuing (started in 1955)
K-131 Cascade Feed	ı	Discontinued - function moved to K-33
K-131 Waste Solutions Recovery Building	1	Discontinued - function moved to K-1420
K-306-7 Product Withdrawal	1	Continuing
K-413 Feed Production Maintenance Shop	l	Continuing
K-601 Sampling Building	'l.	Continuing
K-631 Waste Disposal	l	Continuing
K-1037 Melter Area	1	Discontinued - no air proble indicated; periodically audi
K-1131 Feed Production Area	5 .	Continuing
K-1231 Uranium Pulverizer Area	1	Continuing
K-1301 Oxide Conversion	1	Discontinued - operations terminated
K-1401 Axial Flow Compressor and Allis-Chalmers Pump Shop	1	Discontinued - function requiring monitoring moved to K-1420
K-1401 Converter Preparation Area	3	Discontinued - no air proble indicated; periodically aud
K-1410 Equipment Decontamination	2	Discontinued - primary func- moved to K-1420
K-1413 Design and Development	2	Continuing
K-1420 Equipment Decontamination and Recovery	4	Continuing (started in 1955

SAK:lja 5-17-57

OAK RIDGE GASEOUS DIFFUSION PLANT

SHORT-TERM AIR SAMPLES - 1955 - 1956 - 1957 (THROUGH MARCH)

LOCATIONS WHERE AUDIT SAMPLES WERE OBTAINED BY THE HEALTH PHYSICS STAFF GROUP

THE REALTH FRISTS STAFF GROUP	
Location	Location
Vault 1-X Material Storage	K-305-9 Instrument Shop
Vault 8-A Material Storage	K-305-12 Process Maintenance Shop
Vault 15-A Material Storage	K-306-7 Cylinder Weigh Room
Vault 16-A Material Storage	K-306-7 Field Laboratory
Vault 16-A Office	K-306-7 Product Withdrawal Station
Vault 17-A Material Storage	K-309-3 Process Equipment Test Loop
K-27 Booster Stations	K-312 Section Alumina Traps
K-27 Line Recorder and Seal Exhaust Pumps	K-312-1 Basement, Production Area
K-33 Cascade Feed Room	K-312-2 Basement, Production Area
K-33 Section Alumina Traps	K-312-2 Process Maintenance Shop
K-101 Coolant Recovery	K-312-3 Basement, Production Area
K-131 Cascade Feed	K-402-5 Pump Dismantling
K-131 Feed Production Maintenance Shop	K-413 Feed Production Equipment Electrical Shop
K-131 Waste Solutions Recovery	K-413 Feed Production Equipment Instrument Shop
K-132 Waste Solutions Recovery	K-413 Feed Production Equipment Maintenance Shop
K-301-4 Instrument Shop	K-413 Maintenance Office and Lunch Room
K-301-4 Instrument Shop Office	K-413 Production Area
K-302-1 Process Equipment Test Loop	K-601 Sampling Building
K-302-1 Welding Shop	K-631 Waste Disposal
K-302-5 Cold Trap Room	K-1004-A Sampling
K-302-5 Process Equipment Maintenance Shop	K-1004-J Plutonium Analysis

ORGDP Short-Term Air Samples - 1955 - 1956 - 1957 (Through March) - Locations Where Audit Samples Were Obtained by the Health Physics Staff Group

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Location	Location
K-303-1 Product Cylinder Shop	K-1401 Converter Assembly and Retubing
K-303-1 Seal Shop	K-11:01 Converter Cleaning and Preparation Area
K-303-6 Field Laboratory	K-1401 Converter Scarfing
K-303-6 Process Laboratory	K-1401 Electrical Shop
K-1004-J Radiochemical Laboratory	K-1401 Ferrule Removal Area
K-1024 Acid Room and Valve Repair Shop	K-1401 Spool Modification F-Bay
K-1024 Instrument Shop	K-1h01 Vacuum Pump Shop
K-1025 Feed Storage Building	K-1401 Valve Shop
K-1030 Electrical Shop	K-1410 Equipment Decontamination
K-1031 Material Storage	K-11:10 Office, Locker, and Lunch Room
K-1037 Melter Area	K-1113 Design and Development
K-1131 Feed Production Area	K-1413 Design and Development Equipment Maintenance Shop
K-1131 Offices and Facilities	K-1420 Decontamination Equipment Electrical Shop
K-1131 Process Laboratory	K-11:20 Decontamination Equipment Maintenance Shop
K-1219 Equipment Cleaning	K-1120 Deferruling Booth
~ · ·	K-1120 Equipment Decontamination
K-1231 Uranium Pulverizer Area	K-11:20 Large Equipment Decontamination
K-1301 Oxide Conversion	K-11:20 Process Laboratory
K-1303 Converter Cleaning	K-11:20 Small Parts Decontamination
K-1303 Fluorine Cell Repair Shop	K-1420 Solutions Recovery
K-1401 Axial Flow Compressor and Allis Chalmers Pump Shop	- K-1421 Incinerator Building
K-1401 Compressor Decontamination	
SAK: lja 5-17-57	

OAK RIDGE GASEOUS DIFFUSION PLANT

SHORT-TERM AIR SAMPLES - 1955 - 1956 - 1957 (THROUGH MARCH)

JOBS WHERE AUDIT SAMPLES WERE OBTAINED BY THE HEALTH PHYSICS STAFF GROUP

Location	Operation
K-33 Cooling Tower	Preparation for subcontractor
K-301-5 and K-302-1 Withdrawal Alley	Impeller Change
K-303-3 and K-303-4 Withdrawal Alley	Inpeller Change
K-304-2 Withdrawal Alley	Pump Change
K-304-3 Withdrawal Alley	Impeller Change
K-312-1 and K-312-3 Alumina Trap	Alumina trap change and decontamination
K-902 Withdrawal Alley	Compressor and converter change
K-902-7 Cell 3	Cell clean-up after converter change
K-1004-B Laboratory	Uranium sampling analysis
K-1004-B Uranium Analysis	Uranium plating operation
K-1131 Feed Production Area	Barrier filter change
K-1401 Converter Cleaning Area	Welding inside converter shell
K-1401 Compressor Decontamination	Decontaminating converter spools
K-1401 Cooler Assembly Area	Drilling and welding inside converter shell
K-1401 Cooler Repair Shop	Cooler dismantling
K-1401 Machine Shop	Machining rotors and sanding and balanc- ing impellers and shafts
K-1401 Converter Preparation Area	Cutting and welding inside converter shells
K-1401 Spool Modification Shop	Repairing spools
K-1410 Equipment Decontamination	Barrier filter disassembly and decontamination
K-1413 Design and Development	Operation of Fluorine clean-up reactor
K-1420 Converter Detubing	Converter detubing and grinding operation
K-1421 Incinerator	Burning scrap bags

SAK:lja 5-17-57

LOCATIONS WHERE RESPIRATORY PROTECTIVE DEVICES ARE REQUIRED AT ORGDP

Mandatory by Area

Respiratory protection required for all persons at all times in the following locations:

K-1131 Feed Production

Drum Dumper Area

K-1131 Feed Production

Pit Area

K-1131 Feed Production

Screener Room

K-1131 Feed Production

UO₂ Platform

K-1231 Uranium Pulverizer Area

All Parts

Mandatory by Job

Respiratory protection required for all persons in the affected area when systems are opened or until the job listed is completed, if uranium air contamination is probable.

Cascade Buildings

Changing pumps, seals, converters, and impellers - grinding and buffing

contaminated equipment

Other Process Buildings

Process piping and equipment repair

Alumina Trap Facilities

Trap change and decontamination

Vault 16-A Material Storage

Material transfer and sampling

K-33 Feed

Sampling and connecting and dis-

connecting cylinders

K-101 Coolant Recovery

Withdrawal of contaminated coolant

K-306-7 Product Withdrawal

Connecting and disconnecting cylinders

K-413 Feed Production Maintenance

Feed production equipment dismantling

Shops

and repair

K-601 Sampling

Connecting and disconnecting cylinders

K-631 Waste Disposal

Connecting and disconnecting cylinders

to manifold

K-1004-L Pilot Plant

Changing pumps, seals, converters, and impellers - grinding and buffing con-

taminated equipment

K-1024 Instrument Shop

Equipment decontamination

K-1037 Melter Area

Converter shell repair

Burning of contaminated materials

Mandatory by Job (Cont'd)

K-1131 Feed Production	Sampling - maintenance on powder screws, reduction trays, hoppers, fluorination towers, barrier filters, and other process piping and equipment
K-1401 Equipment Repair Shops	Repair of uranium contaminated valves, motors, pumps, and impellers
K-1410 Equipment Decontamination	Disassembly and decontamination of barrier filters, ash receivers, towers, etc.
K-1413 Design and Development	Sampling, powder handling, equipment maintenance, and routine equipment cleaning
K-1420 Equipment Decontamination	Compressor, converter, and spool dismantling and decontamination - small parts disassembly and decontamination
K-1420 Material Recovery	Material processing and oxide conversion operations

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K-1421 Incinerator

Draft Draft

INTER-COMPANY CORRESPONDENCE

UNION CARBIDE NUCLEAR COMPANY

A Division of Union Carbide and Carbon Corporation

To:

Dr. H. F. Henry

Plant:

Oak Ridge Gaseous Diffusion

Date:

April 29, 1957

Copies To:

Subject:

Air Sampling Program, ORGDP

Attached hereto is a listing of plant locations where air sampling is normally performed, together with the average number of samples obtained per quarter over the past 2-year period. The status of the Constant Air Honitoring equipment is as follows:

A. Plant Fabricated Air Monitors (2)

- 1. 8-31-55 E.S.O. 19321 initiated requesting complete design and, when approved, to prepare work orders and act as Safety and Protection representative to fabricate monitors at ORGDP.
- 2. Account closed temporarily on account current lack of funds; reopened 9-29-55 and Engineering Department (J. Loupe) notified.
- 3. Job rescheduled by Loupe 10-25-55 calling for design completion by 11-15-55; procurement complete by 1-15-56.
- 4. 4-2-56 Report of account #1902-887, estimated cost of plant fabrication and engineering expense.
- 5. 4-3-56 Work Order No. 708169 issued to Maintenance Reissued on 5/31 as M-19321-02.
- 6. Design and procurement of components continue through October, 1956 before shop work is actually scheduled. Meeting held, attended by Messrs. Ulm, Loupe, Henry, and Becher agreed that Engineering will follow as our representative and November 25, 1956 set as completion date.
- 7. 11-28-56 Job incomplete, hardly any shop work done; H. Shnider to advise new schedule; 12-3-56 set as completion date for shop work and 12-14-56 for Instrument Department work.
- 8. Instruments completed and delivered on 3-1-57; calibration studies begin to determine counting and collection efficiency of the constant air monitors. Study also made to set up simplified calibration procedure which could be used by operating groups in the field. This last study completed during week of April 22, 1957.

9. Instruments scheduled for field assignment May 1, 1957 at K-601 and K-306-7.

B. Eight Constant Air Monitors - Contractor-Built

- 1. 7-13-56 E.S.O. M-20782 issued to complete drawings and specifications and procurement.
- 2. 9-10-56 Specifications not completed promised for 9-1-56.
- 3. 11-18-56 Drawings approved.
- 4. 12-7-56 Purchase Requisition No. D-110020, Account No. 1807M-20782-80 issued to procure 8 each Constant Air Monitors; approved 12-19-56.
- 5. 1-3-57 Special Cost Collect Account opened to accumulate costs.
- 6. 2-18-57 First instrument due 6-15-57; remainder due within 30 days following acceptance.
 - Note: A 30-day extension was granted beyond the original date of May 15, 1957 due to Engineering changes by UCNC.
- 7. 4-18-57 6 copies of Manufacturer's Drawings and Specifications forwarded to Instrument Engineering by Material Control Department for approval; J. Loupe advises that manufacturer is on schedule.

A. F. Becher Safety and Health Physics

AFB:msp

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Attachment

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INTER-COMPANY CORRESPONDENCE

UNION CARBIDE NUCLEAR COMPANY

Division of Union Carbide Corporation

To:

Safety and Health Physics

Engineers and Surveyors

Plant:

Oak Ridge Gaseous Diffusion

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Date:

April 20, 1959

Copies To: Dr. H. F. Henry

Subject:

Continuous Air Monitor Operating Instructions

and Calibration Data

Attached are data and basic information relating to the over-all counting and collecting efficiency, calibration procedures, and operating instructions for the subject instrument. Currently, 18 of these units are assigned to operating groups and 2 units are to be maintained by our groups to cover loans, replacements, and special survey requirements.

Items B and C in the attachment cover basic development criteria for initial calibration study; however, items \mathbf{D} through \mathbf{G} , inclusive, delineate calibration check procedure, operating instructions, and adjustments.

As in the past maintenance and repair work will be handled directly by the operating group involved. We will continue to be responsible for the following:

- 1. Field check during regular audits, noting time, date, instrument location, and operating condition.
- 2. Continue follow-up training with operating supervisors to acquaint them with calibrating and operating techniques.
- 3. Replacement of filter paper and register tapes monthly. A note should be made at appropriate place on tape reflecting any unusual operating condition, change in location, etc.
- 4. Identification of tape; signed by the auditor and forwarded to the records unit for file.
- 5. Liaison with Instrument and Engineering Department, and Stores Department to expedite repair, spare parts, etc.

AFB:la

A. F. Becher

Safety and Health Physics

Attachment

Continuous Air Monitor Calibration and Routine Operating Procedure - 4/16/59

No RC

WOX-168 (8-58)

This form for Inter-Company Correspondence only

CONTINUOUS AIR MONITOR CALIBRATION AND ROUTINE OPERATING PROCEDURE

A. <u>Introduction</u>

The continuous air monitor is designed to continuously collect 30-minute air samples, count the alpha particles emitted from the material collected, and record the results in terms of percent of the P.A.L. for air contamination due to uranium. (P.A.L. = 1 count/minute/ft.³ of air.) A five-hour delay between the beginning of sample collection and the end of a sample counting eliminates radiation background due to alpha particles which are emitted by the naturally occurring radon and thoron daughter products which are always present in the atmosphere in varying amounts.

The monitor is provided with two count-recording registers. A half-hour register accumulates the 30-minute "count rate" of the scaler and clears and prints this total in terms of percent of P.A.L. each half-hour period. Whereas the eight-hour register accumulates, then clears and prints the average activity of the (16) half-hour samples taken during an eight-hour period in these same terms. Ample space is provided on the register tapes to make such notations as may be needed to identify locations sampled or conditions existing during sampling periods; the date and time the samples are collected is automatically recorded.

B. Experimental Determination of Counting Efficiency

- The counting efficiency of the monitor was determined experimentally by releasing normal uranium as UO3, UF4, and UF6 (to produce UO2F2) in an enclosed area and collecting air samples of each compound. The samples were counted on a "standard" air monitor and the counting rate thus obtained was compared with the disintegration rate of all of the material collected, as determined by an analysis of the "ashed down" samples; a 15% average counting efficiency for air samples was obtained for the "standard" monitor.
- 2. At this same time, a plated uranium "standard" one-inch in diameter and having a count rate of 5578 counts/minute was counted to provide a means for checking the counting efficiency of the monitor. The average count rate of 4527 counts/minute obtained indicated a counting efficiency of 81.2% for the monitors. Thus, the expected count rate for any comparable source will be 81.2% of the value shown on the source in counts/minute if the detector being checked has the same counting efficiency as the "standard" monitor. The air sample counting efficiency of other monitors is determined

by multiplying the experimentally determined efficiency of the "standard" monitor by the ratio of the actual and the expected count rates from a comparable standard plated film. (See attached sample calibration data sheets.)

C. Calibration

The performance of each monitor was checked initially against the "standard" instrument before the monitor was placed in field operation. Subsequent calibration checks are made at periodic intervals; the frequency of such checks depending upon operating experience. In general, weekly calibration checks are sufficient to assure dependable operation. The following procedure covers the proper method of making the original calibration and subsequent calibration checks of a typical air monitor.

- Obtain an air-flow rate correction for rotameter readings, using the following methods
 - a. Set the rotameter at two and read the vacuum gauge. Record both readings on the prepared calibration data sheet and repeat the process at rotameter settings of three, four, five, and six.
 - b. Obtain pressure correction factors for each vacuum gauge reading and record.
 - c. Multiply rotameter setting by the correction factor to obtain the true flow rate (record as Required Air Flow - F - Sample 1).
 - d. Plot a curve of Rotameter Setting vs. Required Air Flow - F (Sample 2).
- 2. Determine the correct operating voltage and sensitivity settings. The sensitivity is set at one-fourth volt by the Instrument Shop and should not normally require changing; however, the point indicated on the calibrated dial should be recorded.

Method:

a. Check the detector tube height adjustment to assure that the window mounting ring is flush with the bottom of the holder.

- b. Center the detector tube on the standard plated uranium source furnished with the monitor.
- c. Set the scale factor on 64 and take a series of counts at detector voltages ranging from 850 to 1250. Normally, the operating voltage should <u>never</u> exceed 1250 volts.
- d. Using the calibration data sheet, record detector voltage, register counts plus any remaining lights on the scaler, half-hour register counts, eight-hour register counts, scale factor, and counting time. <u>All register counts</u> should be essentially the same.
- e. Using data obtained on the scaler, calculate the scaler total counts per minute (c/m) and plot alpha c/m vs. detector head voltage with voltage as the abcissa.
- f. Select as the operating voltage a point which falls in the middle of the plateau of the curve (usually, this is about 1000 volts) and record.
- g. Place the detector tube on a piece of clean paper and take a five-minute background count at the voltage selected in f. above. The background should not exceed about 0.2 counts per minute.
- Obtain average counting rate of plated uranium standard.

Method:

- a. Place the detector tube on plated standard making certain the standard is centered under the detector.
- b. Count the standard four times (three-minute counts) at the selected operating voltage and sensitivity settings, record the data, and determine the average counting rate (C_2) . The average count rate should be about 80% of the value shown on the standard.
- c. Compute the acceptable range of C_2 for subsequent checks.

Acceptable count range = $C_2 + 2\sqrt{C_2}$.

4. Determine air monitor counting efficiency, G, (Sample 3).

. Method:

a. Obtain the average counting rate (C_2) of the monitor for a one-inch diameter plated uranium standard (C_1) .



b. Counting efficiency (G) of air monitor being calibrated is given by:

$$G = \frac{C_2}{0.812 C_1} \times 0.15$$
 where

C₁ = Counting rate of one-inch diameter uranium standard in counts/minute obtained by the "standard" instrument.

 C_2 = Average counts/minute obtained on air monitor.

5. Determine flow rate (F) at which monitor must be set.

Method:

$$F = \frac{0.5662}{G}$$
 where

G = Counting efficiency determined in 4. above.

- 6. Set rotameter at the proper flow as interpreted from graph of true air flow vs. rotameter reading.
- D. Calibration Check (Sample 3)

Method:

- 1. Turn scaler high voltage switch to "off" position.
- 2. Disconnect high voltage lead to detector tube.
- 3. Remove sampler hood.
- 4. Remove detector tube and center it over the plated uranium standard provided.
- Replace high voltage lead and turn high voltage to "on" position.
- 6. Adjust voltage to value shown on calibration log sheet.
- 7. Turn scale factor to 64.
- 8. Count the plated standard for ten minutes and calculate the average count rate. If the counting rate falls within the acceptable range recorded on the calibration log, no changes are required. However, if the counting rate does not fall within the acceptable range, enter the new rate under C₂ on the calibration log and calculate new values for acceptable range, counting efficiency, and air flow required.

9. Obtain the new rotameter setting from the air flow correction curve, record the value, and adjust the rotameter accordingly.

E. Operation

Air monitor start-ups

1. Scaler

Turn master and high voltage switch to "off" position and turn high voltage control to extreme left.

2. Registers

Turn on-off switches on both registers to "off" position.

3. Turn instrument switch located on pump end of monitor to "on" position.

4. Scaler

- a. Turn master switch "on" and allow one minute for warm up.
- b. Turn high voltage switch "on," wait until the meter needle moves upward, then set the detector voltage at the calibrated value by turning the voltage control to the right.

Caution: DO NOT EXCEED THE VOLTAGE AT WHICH THE MONITOR WAS CALIBRATED.

- c. Set scale selector switch to 16.
- d. Clear scaler by operating reset control and moving knurled wheel upward until the manual register on the scaler is at zero.
- e. Turn the count switch to "on" position.

5. Registers

- a. One-half hour register
 - (1) Turn on-off switch to "on" position.
 - (2) Push red button to actuate the printing mechanism. The time and accumulated count will be printed, the register will "clear," and the time wheels will advance one-half hour.

- (3) Set printer to read five hours prior to the present correct time by actuating the manual control (red button). Example: If the correct time is 10:15 a.m., the last time printed should be 5:00 a.m. The first five printed represents 5:00 a.m., and the second five printed represents 5:30 a.m.
- (4) Set the timer clock at the correct number of minutes beyond the hour. Example: If the correct time is 10:15 a.m., set the timer at 15.

b. Eight-Hour Register

- (1) Turn on-off switch to "on" position.
- (2) Depress red button to actuate printing mechanism. The time, date, and accumulated count will be printed, and the register will "clear."
- (3) Set the time and date print wheels to read five hours prior to the present correct date and time by depressing the release lever on the side of the stamp and advancing the print wheel manually. The selected time should correspond to that of the one-half hour register.
- (4) Set the timer clock to read the number of hours and minutes after the beginning of a shift, which is indicated by the time selected in (3) above. Shifts begin at 12 midnight, 8:00 a.m., and 4:00 p.m.

6. Set Air Flow Rate

- a. Turn pump switch to "on" position.
- b. Set rotameter to the value shown on the calibration log by adjusting the flow valve.

7. Check Pump Oil Level

See instructions printed on oil level indicator.

F. Changing Filter Paper: (Stores Catalog No. 15-157-0502)

1. Scaler

Turn master and high voltage switch to "off" position and turn high voltage control to extreme left.

2. Power Supply

Trip both power breakers to "off" position.

3. <u>Detector Head</u>

Unscrew and remove high voltage cable connection.

4. Aluminum Cover

Remove cover in a level position taking care to pull the air intake funnel away from the filter paper to avoid cutting the paper.

5. Installing New Roll of Paper

- a. Loosen clamp nut located between the two sprocket chain drives on the paper take-up end.
- b. Slide slotted bracket located between the two chain sprockets clear of take-up reel shaft.
- c. Pull roll of used paper and drum out of the slot and remove chain from sprocket.
- d. Clear the drum of used paper.
- e. Insert paper drum back in position by reversing the removal procedure.
- f. Loosen tension rubber guide rollers at paper drive drum.
- g. Pull paper holder and paper spool out of the slot on the inlet end of the paper drive unit.
- h. Install new roll of paper so it unwinds upward from the outside, positioning it so it unwinds clockwise with the paper coming off of the bottom of the roll.
- i. Feed the paper over the guide roller, under and up around the suction head, then over the top of the support rod and between the shelf and scintillator tube. Pull about eight inches of slack in paper and feed end of paper around paper drive drum and then over the guide roller. Tighten guide rollers just enough to hold paper on drum. Place end of paper on the center of the take-up drum and attach with tape removing any slack in paper. Manually actuate paper drive ratchet relay two or three times to ascertain if paper drive is operating satisfactorily. Reposition paper alarm trolley shoe and make certain it is riding on surface of the paper.
- j. Re-install cover being careful to avoid damage to paper; reconnect high voltage lead to detector head.

- 6. Removal of Register Tapes at the Close of Each Calendar Month
 - a. Wind the balance of the paper tape until all printed matter is on rewind spool.
 - b. Cut tape off where it leaves the paper guide.
 - Remove clip from tape spool on lower left-hand side and carefully slide tape from spool.

7. Replacement of Register Tape

- a. Remove tape roll retainer wing nut on lower right-hand side of spool and remove any remaining tape.
- b. Install new tape roll on spool so that tape unwinds in a clockwise direction and replace wing nut and tape retainer.
- c. Insert tape within flanges of paper guide.
- d. Place tape between tape feed rollers with approximately a six-inch leader strip.
- e. Wind tape once around lower left-hand spool and slip tape clip in groove with paper between spool and clip.

G. Routine Check List (Check each shift)

- . 1. See that filter paper is not broken; this should be detectable by activation of the alarm bell mounted underneath the top shelf. Rethread if necessary.
 - 2. The following should correspond to data shown on the calibration sheets:
 - a. High voltage setting.
 - b. Scale factor (16).
 - c. Rotameter setting.
 - 3. Count switch should be in "count" position.
 - 4. Pump and instrument switches should be in "on" position.
 - Oil in pump reservoir should be in accord with instructions printed on oil reservoir. Service with S.A.E. No. 10.
 - 6. Time registered on recorded tape should be five hours earlier than the correct time.

- 7. Check the half-hour recorder tape. If a series of readings show no variation, the instrument is not operating properly and any of items 1 through 4 above could be at fault.
- 8. Date and time registered on eight-hour recorder at the last time shown should be the end of the previous shift, i.e., 4:00 p.m., 12 midnight, or 8:00 a.m.
- 9. Note any change in location of the sampler at the appropriate place on the register tape, as well as any unusual condition such as power failure, instrument repair, replacement of tape, etc.

Attachments:

Sample Calibration Sheets (Samples 1-4)

Safety and Health Physics Industrial Relations Division April 16, 1959

SAMPLE 1 CALIBRATION DATA

Continuous Air Monitor Serial No. 10

Date: <u>11/4/58</u>

<u>Calibrate</u> on scale of 64 - <u>Operate</u> on scale of 16

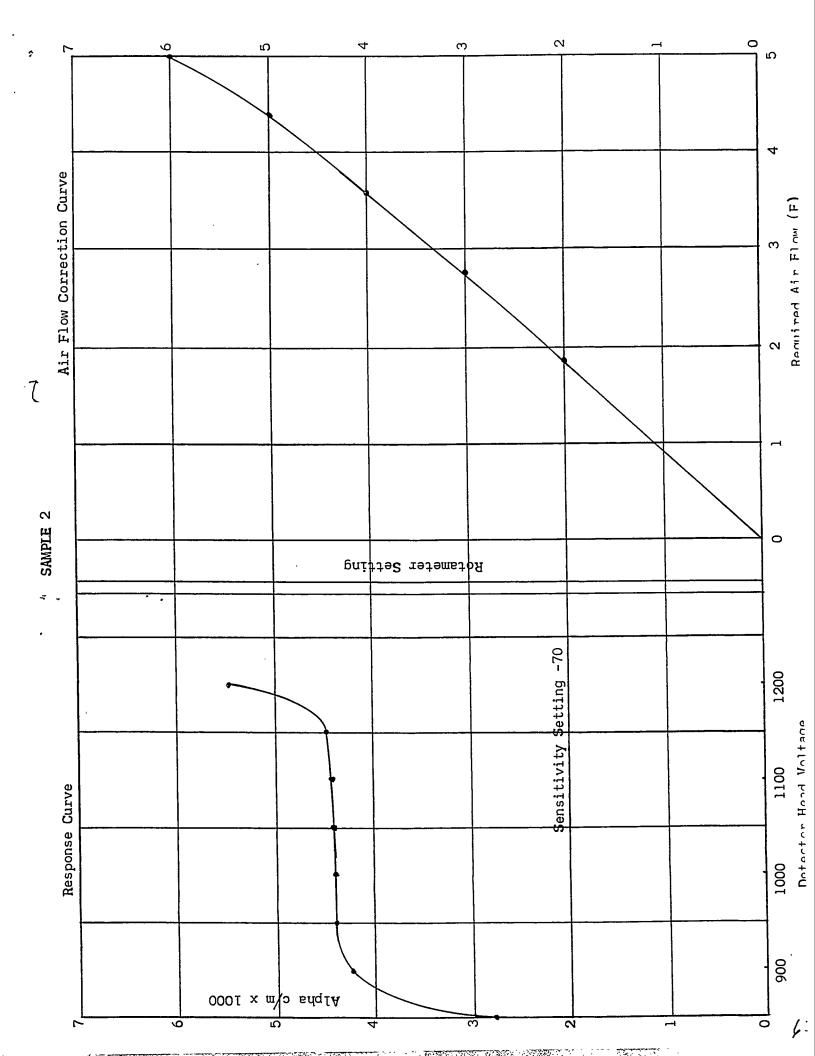
By & __U. Man

<u>Jaribra</u>	cc on scare o	1 0+ <u>Opera</u>	ce on scare or	10	Dy 4	7. Maii		
Detector Voltage	Scal Register Counts	er Number Lights	l/2-Hour Register Counts	8-Hour Register Counts	Scale Factor	Counting Time - Minutes	Scaler Total c/m	
Response Curve								
850	131	31	131	131	64	3	2805	
900	198	8	198	198	64	3	4227	
950	205	10	205	205	64	3	4377	
1000	206	6	206	206	64	3	4397	
1050	205	17	205	205	64	3	4379	
1100	206	21	206	206	64	3	4401	
1150	207	52	207	207	64	3	4433	
1200	256	33	254	253	64	3	5472	
1250	375	27	343	355	64	3	8009	
		Ave	rage Counting	Rate - C ₂				
1000	206	10			64	3	4398	
1000	206	48			64	3	4411	
1000	. 205	51			64	3	4390	
1000	207	0			64	3	4416	
AVERAGE C ₂					4404			

Source No. <u>2096</u>
Activity <u>5587</u> c/m

Detector Head No. 836
Sensitivity Setting 70

Rotameter Setting	Vacuum Gauge Reading	Correction Factor	Required Air Flow - F (True Flow Rate)
	Air Flow	Rate Correction Cur	ve
2	2.75	0.943	1.9
3	3.75	0.924	2.8
4	5.10	0.898	3.6
5	6.40	0.872	4.4
6	7.90	0.842	5.1



SAMPLE 3

CALIBRATION LOG

Continuous Air Monitor Serial No. 10

Calibrate on scale of 64

Detector Operating Voltage 1000

Operate on scale of 16

Detector Head No. 836

	Alpha c/m		Calibration Check Acceptable Range		Counting	Air Flow (CFM)	
	Alph	a C/III	Acceptab	le Kange	Efficiency	Required	Rotamete.
Date	c_1	C ₂	$C_2 + \sqrt{C_2}$	$c_2 - 2\sqrt{c_2}$	G	F	Setting
11-4-58	5587	4404	4537	4271	0.146	3.88	4.3
12-4-58	5587	4387	Calibration	check - no	change require	d.	
1-4-58	5587	4500	Calibration	check - no	change require	d.	
2-4-58	5587	4200	4330	4070	0.139	4.07	4.46
					,		
							-
•				-			*****
_							-

 $C_{\mbox{\scriptsize l}}$ = Counting rate of one-inch diameter plated uranium standard.

 C_2 = Average counting rate obtained on monitor for above standard.

G = Calculated counting efficiency.

F = Required air flow.

Formulas:
$$G = \frac{C_2}{0.812 C_1} \times 0.15$$

 $F = \frac{0.566}{G}$

Safety and Health Physics Industrial Relations Division April 16, 1959

SAMPLE 4

CONTINUOUS AIR MONITOR - PRESSURE CORRECTION FOR ROTAMETER

In. H _g <u>Vacuum</u>	Correction <u>Factor</u>	In. H _g <u>Vacuum</u>	Correction Factor
0.00	0 . 990	5.25	0.895
0.50	0.982 '	5.50	0.890
1.00	0.975	5.75	0.886
1.25	0.970	6.00	0.881
1.50	0.967	6.25	0.876
1.75	0.963	6.50	0.871
2.00	0.958	6.75	0.867
2.25	0.953	7.00	0.862
2.50	0.949	7.25	0.857
2.75	0.945	7.50	0.852
3.00	0.940	7.75	0.847
3.25	0.935	8.00	0.842
3.50	0.930	8.25	0.837
3.75	0.925	8.50	0.831
4.00	0.920	8.75	0.827
4.25	0.915	9.00	0.820
4.50	0.910	9.25	0.815
4.75	0.905	9.50	0.810
5.00	0.900	9.75	0.805
		10.00	0.800

Safety and Health Physics Industrial Relations Division April 16, 1959



DETAILED DESIGN OF A FIXED FILTER-PAPER ALPHA-AIR-MONITOR WITH LESS THAN 15-min RESPONSE TIME

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UNITED STATES OF AMERICA

Reprinted from "NUCLEAR ELECTRONICS III"



INTERNATIONAL ATOMIC ENERGY AGENCY VIENNA 1962

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Abstract — Résumé — Авнотация — Resumen

Detailed design of a fixed filter-paper alpha-air-monitor with less than 15-min response time. The primary health physics problem at the gaseous diffusion plants, where uranium isotopes are separated, is that of airborne alpha-emitting uranium dust. A programme to provide better instrumentation for detecting this dust has been underway at the Oak Ridge Gaseous Diffusion Plant for several years. This paper discusses a recently developed instrument that provides a rapid alarm if the airborne uranium dust from a release reaches hazardous levels.

Before its development a delay of approximately 5 h was required to allow natural atmospheric radioactivity to decay before long-lived alpha emitters from uranium dust could be detected. This recently developed instrument functions on the principle that when airborne dust containing natural atmospheric radon daughters is collected, the activity will increase to a quasi-equilibrium value at which time the rate of deposition will be equal to the rate of decay. The uranium dust is then observed as a rapid change from equilibrium conditions. A unique feature of the instrument is the use of a special differentiating circuit to actuate an alarm when the rate of increase of radioactivity exceeds that which can be expected from the diurnal variations in atmospheric radioactivity levels.

The development model of this instrument uses a vacuum pump to draw air through a filterpaper disc which collects the entrained dust particles. The alpha radiation from the dust is detected with a scintillation detector. The electronic circuitry consists of amplifiers and rate circuits which provide monitored outputs proportional to both the level of radioactivity and the rate of change in this level. One circuit utilizes a special very high capacity electrolytic capacitor which has been subjected to extensive testing to determine that certain leakage requirements can be met. In addition, special attention has been paid to the problem of not actuating the alarm on statistical fluctuations. Twelve transistors are used in the circuit.

This monitor features small size and simplicity, with an economy in fabrication, operation, and maintenance not available in other known monitor designs. It provides an alarm within 15 min when uranium dust concentrations exceed $2.1 \times 10^{-10} \, \mu c/cm^3$ (three and one-half times the maximum permissible concentration for a 40-h week exposure). Additionally, it can be used to measure the average weekly uranium dust concentration by the removal of the filter disc and the measurement of its radiation level after an appropriate decay period.

Détecteur d'aérosols contenant des émetteurs alpha, muni d'un papier filtre fixe, à temps de réponse inférieur à quinze minutes. Dans une usine de séparation des isotopes de l'uranium par diffusion gazeuse, les particules alpha émises par les aérosols d'uranium posent un grave problème de radioprotection. A l'usine de séparation par diffusion gazeuse d'Oak Ridge on a entrepris, il y a quelques années, l'exécution d'un programme qui a pour objet de perfectionner les appareils de détection des aérosols. Le mémoire décrit un appareil récemment mis au point qui déclenche rapidement un avertisseur si le dégagement d'aérosols d'uranium atteint le seuil de danger.

Avant la mise au point de cet appareil, il fallait attendre cinq heures environ pour permettre la décroissance de la radioactivité naturelle de l'atmosphère avant que les émetteurs alpha à longue période contenus dans les aérosols d'uranium ne puissent être décelés. Le fonctionnement de l'appareil considéré est fondé sur le principe suivant: lorsque l'on recueille des aérosols contenant des produits de filiation du radon à l'état naturel dans l'atmosphère, l'activité augmente jusqu'à ce qu'elle atteigne une valeur de quasi-équilibre. A ce moment, la vitesse de dépôt sera

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égale à celle de la décroissance. La présence d'aérosols d'uranium entraîne une modification rapide des conditions d'équilibre, que l'on peut observer. L'appareil a ceci de particulier qu'un circuit spécial de différentiation actionne un avertisseur dès que le taux d'accroissement de la radioactivité dépasse celui auquel on peut s'attendre du fait des variations diurnes de la radioactivité atmosphérique.

Le prototype de l'appareil comprend une pompe à vide qui aspire l'air pour le faire passer à travers un disque de papier filtre sur lequel se déposent les aérosols. Le rayonnement alpha émis par les aérosols est décelé au moyen d'un scintillateur. Le montage électronique comprend des amplificateurs et des circuits de débitmètres et fournit des données proportionnelles au niveau de la radioactivité et à la vitesse des variations de ce niveau. L'un des circuits comprend un condensateur électrolytique à très haute capacité qui a été soumis à des essais prolongés pour s'assurer que certaines conditions de fuite peuvent être remplies. En outre, il a fallu veiller tout particulièrement à ce que des fluctuations statistiques ne suffisent pas pour déclencher l'avertisseur. Douze transistors ont été utilisés dans le circuit.

Ce détecteur est moins encombrant et plus simple que les autres types connus. Il peut être fabriqué à meilleur compte et son fonctionnement et son entretien sont plus économiques. Il déclenche l'avertisseur quinze minutes après que les concentrations d'aérosols d'uranium ont dépassé 2,1·10-10 μc/cm³ (soit trois fois et demie la concentration maximum admissible pour une exposition de 40 heures par semaine). Il peut aussi servir à mesurer la concentration hebdomadaire moyenne d'aérosols d'uranium. A cet effet, on enlève le disque en papier filtre dont on mesure la radioactivité après une certaine période de décroissance.

Подробная конструкция воздушного регистратора альфа-частиц с фиксированным бумажным фильтром со временем срабатывания менее пятнадцати минут. Основной дозиметрической проблемой на газовых диффузионных заводах, где происходит разделение изотопов урана, является регистрация урановой пыли в воздухе, излучающей альфа-частицы. В течение нескольких лет на Окриджском газовом диффузионном заводе осуществляется программа разработки более совершенных контрольно-измерительных приборов для обнаружения этой пыли. В данном докладе обсуждается разработанный недавно прибор, который обеспечивает подачу быстрого тревожного сигнала, если концентрация освобождающейся урановой пыли в воздухе достигает опасных уровней.

До разработки этого прибора необходима была примерно пятичасовая задержка, которая давала время для распада естественной атмосферной радиоактивности, прежде чем можно было обнаружить долгоживущие альфа-излучатели урановой пыли. Разработанный недавно прибор работает на следующем принципе: когда собрана пыль в воздухе, содержащая дочерние продукты естественного атмосферного радона, активность возрастет до квази-равновесного значения, при котором скорость осаждения будет равна скорости распада. В таком случае урановая пыль наблюдается по мере быстрого изменения условий равновесия. Уникальной характеристикой прибора является использование специальной дифференцирующей схемы для подачи тревожного сигнала, когда скорость увеличения радиоактивности превышает скорость, которую можно ожидать от суточных колебаний в уровнях радиоактивности атмосферы.

В модели этого прибора используется вакуумный насос для откачивания воздуха через бумажный фильтрующий диск, который собирает входящие в него частицы пыли. Альфарадиация пыли обнаруживается с помощью сцинтилляционного детектора. Электронная схема состоит из усилителей и скоростных схем, которые обеспечивают показания обнаруженной радиоактивности, пропорциональной ее уровню и скорости изменения такого уровня. Одна схема использует специальный очень мощный электролитный конденсатор, который прошел тщательные испытания, для определения отсутствия какой-либо утечки. Кроме того, особое внимание уделялось проблеме предотвращения воздействия на сигнал статистических флуктуаций. В цепи используется двенадцать транзисторов.

Этот прибор отличается малым размером, простотой и экономичностью при производстве и эксплуатации, которых недостает другим приборам известной конструкции. Концентрация урановой пыли свыше 2.1×10^{-10} микрокюри/см 3 (в три с половиной

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раза больше максимально допустимой концентрации для 40-часового облучения в неделю) может быть обнаружена приблизительно через 15 минут. Кроме того, он может быть использован для измерения средней еженедельной концентрации урановой пыли путем удаления бумажного фильтра и измерения его радиационного уровня после соответствующего периода распада.

Monitor de hoja de papel filtro fija para emisores alfa suspendidos en el aire, cuyo tiempo de reacción es inferior a 15 minutos. El polvo de uranio, emisor alfa, que se halla en suspensión en el aire plantea el principal problema de higiene radiofísica en las instalaciones de difusión gaseosa destinadas a la separación isotópica del uranio. Desde hace varios años se está ejectuando en la instalación de difusión gaseosa de Oak Ridge un programa de perfeccionamiento de los instrumentos para la detección de este polvo. La presente memoria discute un nuevo instrumento que emite rápidamente una señal de alarma cuando la concentración del polvo de uranio suspendido en el aire alcanza un valor peligroso.

Antes de que existiera este aparato, eran precisas aproximadamente 5 horas para dar tiempo a que disminuyese la radiactividad atmosférica natural y que se pudieran detectar los emisores alfa de largo período de desintegración presentes en el polvo de uranio. El instrumento funciona con arreglo al siguiente principio: cuando se recoge el polvo que contiene los productos de filiación del radón atmosférico natural, la actividad aumenta hasta alcanzar un valor de cuasi-equilibrio, en que la velocidad de deposición será igual a la de desintegración. La presencia del polvo de uranio se manifestará entonces por una rápida alteración de las condiciones de equilibrio. El instrumento se caracteriza por el hecho de emplear un circuito diferenciador especial que dispara una alarma cuando la velocidad con que aumenta la radiactividad supera a la que cabe esperar por las variaciones diurnas de los niveles de radiactividad atmosférica.

El modelo experimental de este instrumento emplea una bomba de vacío que aspira el aire a través de un disco de papel de filtro que detiene las partículas de polvo. La radiación alfa que emite el polvo se detecta con un centelleador. La parte electrónica del dispositivo consiste en circuitos amplificadores e integradores que dan impulsos de salida proporcionales a la cantidad de radiactividad y a la velocidad con que esta cantidad varía. Uno de los circuitos comprende un condensador electrolítico especial de capacidad sumamente elevada que se sometió a numerosos ensayos para cerciorarse de que satisface ciertas exigencias en lo referente a las pérdidas. Además, se ha prestado especial atención al problema de evitar que el dispositivo de alarma entre en acción cuando las fluctuaciones son de carácter estadístico. En el circuito se utilizan 12 transistores.

El aparato se caracteriza por su pequeño tamaño y su sencillez, así como por el hecho de que su construcción, empleo y conservación resultan mucho más económicas que las de cualquiera de los monitores conocidos hasta el presente. Da una señal de alarma en menos de 15 min cuando la concentración del polvo de uranio supera los 2,1 · 10⁻¹⁰ µc/cm³ (tres veces y media la concentración máxima admisible para una exposición de 40 h por semana). Además de emitir esa señal de alarma, el monitor permite medir la concentración semanal media del polvo de uranio, quitando el papel de filtro y midiendo la intensidad de la radiación después de un período conveniente de desintegración de la actividad natural.

I. Introduction

The design of instrumentation for rapidly detecting hazardous dust levels of long-lived alpha emitting substances such as uranium is complicated by natural atmospheric radioactivity which results from the decay of radon and thoron gas in the air. These radioactive gases are exhaled into the atmosphere from the earth's surface as a result of radioactive transmutation of uranium and thorium which is widely distributed in the earth's crust. Although a more or less constant supply of radon and thoron gases is given up to the atmosphere, the amount of natural radioactivity near the surface

of the earth is found to vary widely. This fluctuation results largely from changes in meteorological conditions that affect the rate of mixing of these radioactive gases and their daughter products with the major components of the atmosphere.

The decay of uranium and thorium proceeds in accordance with the standard decay series discussed in numerous textbooks on radioactivity. Pertinent data on the principal transmutation products of the uranium and thorium series, which are necessary to an understanding of the problem caused by natural radioactivity when monitoring for uranium dust, have been compiled in Table I [1] for reference. It should be noted that uranium is a long-lived alpha emitter with a half-life of 4.55×10^9 yr. The combined alpha-emitting natural background from radon and thoron daughters has a half-life of about 46 min. The following circumstances combine to make it difficult to monitor a working area for airborne uranium dust and sound an alarm when the dust level becomes hazardous:

- (a) The permissible amount of uranium dust in the atmosphere, where workers are continuously exposed during a 40-h work week, is very small. The plant allowable limit is 1.4 pc/ft³ (50 × 10⁻⁶ pc/cm³);
- (b) The interfering alpha radiation from short-lived radon and thoron daughters is often twenty times greater than the alpha radiation from the permissible amount of airborne uranium dust;
- (c) It is impossible to collect the uranium dust that results from a uranium hexafluoride release from a known quantity of air and thereby increase sensitivity without collecting the radon and thoron daughter products which cling to atmospheric dust;
- (d) Natural background varies greatly as meteorological conditions change. Temperature inversion is a major factor responsible for these variations. Fig. 1 shows a correlation of temperature inversion and natural background. During a temperature inversion, radon and thoron accumulate near the earth's surface causing an increase in radio-activity. Hence, natural background becomes a variable which may change hourly and from day to day. Data that demonstrate the magnitude of these variations are shown in Fig. 2. These data are typical of observations accumulated over a period of six months while monitoring background to determine the alarm-rate setting for this instrument;
- (e) The size of the dust particles formed during a uranium hexafluoride release varies and approaches the size of atmospheric dust. An instrument based on the impaction method of collection covered in a report by TAIT [2] was tried as a gross release detector, but the collection efficiency of UO₂F₂ dust was so low that adequate sensitivity could not be obtained.

If the atmospheric dust is continuously entrapped on a filter-paper disc, a quasiequilibrium condition will occur in which the rate of arrival of new radioactivity is equal to the decay rate of material previously collected. This equilibrium radioactivity level will vary slowly as the natural background activity varies. If the instrument monitoring this rate of change is adjusted so that the maximum rate of increase in natural background is slightly below the threshold of alarm, then any release above the rate of background rise will cause the instrument to alarm.

Obviously, the sensitivity of such an instrument is dependent on the rate of background change. However, the minimum sensitivity, even in the presence of a falling background, is sufficient to give a warning before a serious hazard has existed for sufficient time to be injurious to health.

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Table I
THE URANIUM AND THORIUM SERIES

Element	Atomic number	Half life	Type and energy of radiation (MeV)			
			CL.	β	γ	
Uranium	92	$4.5 \times 10^9 \mathrm{yr}$	4.21	i		
Radium	88	1600 yr	4.79	i	0.19	
Radon	86	3.83 d	5.49	•		
Radium A	84	3.05 min	5.99			
Radium B	82	26.8 min		0.65		
Radium C	83	19.7 min	5.50	3.15	1.8	
Radium C'	84	1.5 × 10-4 s	7.68			
Radium C''	81	1.32 min		1.8		
Radium D	82	22.2 yr		0.025	0.047	
Thorium	90	$1.34 \times 10^{10} \mathrm{yr}$	4.2	-		
Thorium X	88	3.64 d	5.68	1		
Thoron	86	54.5 s	6.28	; i		
Thorium A	84	0.16 s	6.77	į		
Thorium B	82	10.6 h		0.36		
Thorium C	83	60.5 min	6.05	2.2		
Thorium C'	84	3 × 10-7 s	8.77] .		
Thorium C''	81	3.1 min		1.82	2.62	
Thorium D	82	stable				

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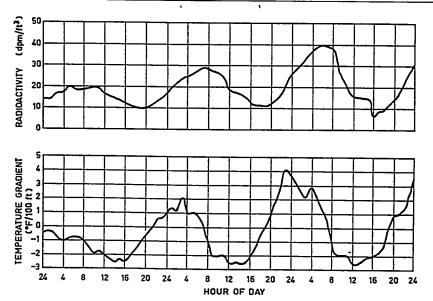
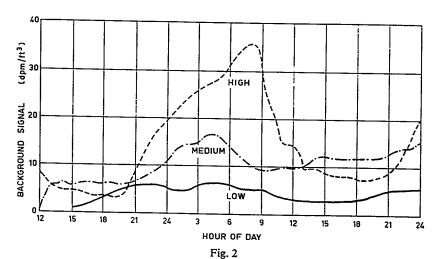


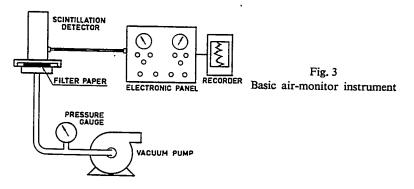
Fig. 1 Variation of radioactivity and temperature gradient with time



Typical background charts from fixed filter-paper instrument

II. Design

The major components of the Air Monitor are shown in Fig. 3. The positive displacement vacuum pump draws air at about 5 standard ft³/min (140 l/min) through slots in the sides of the filter-paper holder and then through the filter paper itself. A vacuum gauge is provided on the suction side of the pump to indicate the pressure drop across the filter. The filter is renewed when the change in gauge reading indicates that the air flow has been reduced by 20%. In most locations a filter will operate for at least 7 d.



The filter paper, known commercially as "Millipore"* is pure cellulose acetate with a pore size of $0.8~\mu$ and diam. of 4 in (10 cm). Because of its extreme fragility it is necessary to use a backup filter of very large pore size for support. As airborne dust is collected on the filter, it does not become embedded, but tends to lie on the surface, thus minimizing any tendency of the filter paper to plug.

*

K.

^{*} The Millipore Filter Corporation, Bedford, Mass., United States of America.

The Model Q-2101 scintillation detector was developed by the Oak Ridge National Laboratory. It consists of a 2-in (5 cm) multiplier phototube surveying a square area 4.5 in (11.5 cm) on a side. The active element consists of a block of acrylic plastic 0.25 in (0.64 cm) thick with a silver activated zinc-sulphde mixture sprayed on one side. The other side of the block is light-coupled to the face of the phototube with silicon grease.

Fig. 4 is a schematic diagram of the instrument circuit. Pulses from the phototube (T-1) are amplified in a pulse amplifier (T-2 thru T-7) and trigger a one-shot multivibrator (T-8, T-9) suggested by Spear [3]. The input-pulse trigger level may be adjusted by the input sensitivity control over the range of 5 to 500 mV. Typical operation is with an input sensitivity of 100 mV. The counting efficiency at this setting is about 45% of the total disintegrations, or about 90% of the disintegrations coming off of the detector side of the filter disc.

The full-scale range of the instrument may be selected by means of the range switch as either 20000 or 40000 disintegrations/min dependent on the size of a capacitor in the feedback loop of the multivibrator.

The output voltage of the multivibrator is filtered and amplified by the pulse-rate DC-amplifier (T-10, T-11) and produces a current proportional to the pulse rate. This current is monitored by a milliammeter and a miniature strip-chart recorder.

The voltage produced by this output current flowing through a potentiometer resistance element serves as the input to an RC differentiating circuit, of which C is a very large capacitor, and R is a combination of the resistance of the alarm-rate control, the output resistance of the pulse-rate DC amplifier, and the input resistance of the alarm-rate DC amplifier (T-12, T-13).

Neglecting capacitor leakage, for a rising voltage whose rate of increase is constant, the steady-state capacitor-charging current is proportional to the rate of rise. This current is amplified and presented as a milliammeter deflection.

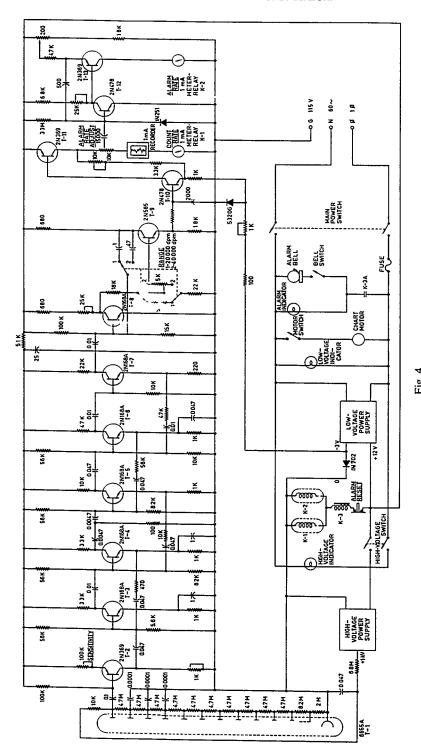
The alarm-rate control permits the circuit to be adjusted so that any collection rate between 15 and 1500 pc/min will cause the instrument to alarm. Fig. 5 shows the time to alarm over a range of collection rates for an alarm rate setting of 17.6 pc/min.

Any leakage current of the large capacitor in the differentiating circuit will act as a bias current as far as the signal is concerned. Since in practice the charging current and leakage current cannot be separated, it is necessary that the leakage current be small compared with the charging current. The maximum value of the leakage current has been set arbitrarily at 10% of the minimum charging current which will cause an alarm.

In choosing a capacitor for this application, it is necessary to obtain the highest ratio of capacity to leakage current using voltages within the limitations of transistors. The capacitor finally selected was a type 32D aluminium electrolytic unit rated at 15000 μ F, 15 V, manufactured by the Sprague Electric Company, North Adams, Mass., USA. The manufacturer of this capacitor is able to obtain extremely low leakage by the use of very high-purity etched aluminium foil, by using special techniques for forming the foil oxide, and by the use of a conservative design regarding operating voltage. When placed on charge at 9 V, the leakage dropped to 0.3 μ A within 24 h. A similar capacitor manufactured by P. R. Mallory and Company, Indianapolis, Ind., USA, has also performed satisfactorily. The maximum voltage into the differentiating circuit was chosen as 10 V.

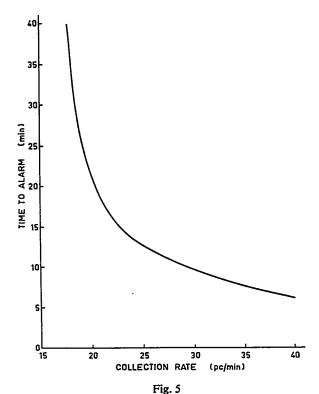
V:

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Complete schematic diagram — air monitor All capacitance in μF ; all resistance in \mathfrak{U} ; $K=X10^3$; $M=X10^6$

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Alarm time (with alarm-rate control set at 17.6 pc/min)

The alarm-rate control setting is usually adjusted to make the instrument as sensitive as possible without alarming from increases in background. Since the maximum rate of rise in background over several months of observations was about 40 disintegrations/min, this rate was chosen as the minimum alarm-rate setting. At this rate, the alarm circuit voltage will rise 20 mV/min, and the capacitor charging current, based on a 15000- μ F capacitor, will be 5 μ A.

In order to prevent the instrument from alarming from statistical fluctuations, capacitive feedback is employed in the alarm rate amplifier. Since the addition of this capacitor increases the effective time constant of the alarm-rate amplifier, its maximum capacity is limited. Additional filtering for damping statistical fluctuations is not used in the count-rate DC-amplifier circuit because a very large capacitance would be required, and the time response of the amplifier would be increased excessively. Both the high and low-voltage power supplies are commercially available modules.

III. Performance

A prototype air monitor has been built, and has operated in the plant over the past several months. Beside some malfunctions of a minor nature, operation has been satisfactory. The instrument has detected known releases, and has not indicated any

false alarms. The final model of the air monitor is at present in the design stage. Present plans call for housing the entire instrument in a cabinet 18 in (46 cm) high, 18 in (46 cm) deep, and 30 in (78 cm) wide.

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 SPEAR, W. G., A Scintillation Transistorized Alpha AC 'Poppy' Monitor, Hanford Atomic Products Operation (Richland, Washington, U.S.A.) Report HW-57506 (1959).

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NEW CONCEPT PERSONALIZED AIR SAMPLING

The standard practice of locating dust sampling equipment in areas remote from a hazardous operation can now be superseded by use of this personnel sampler. The problem of sampling in areas inaccessible to lorger and heavier equipment has also been minimized. With this LAPEL SAMPLER, you can sample the atmosphere in the immediate breathing vicinity of the individual at all times. Because it is so compact and light, the user is unaware of its presence and has the assurance of being constantly manifored and the



PLIRONICS MODEL BC

INTRODUCING THE NEW BREATHING ZONE" AIR SAMPLER

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Since the LAPEL SAMPLER samples at a flow rate of 3.5 liters per minute with a findiameter Whatmen 41 filter paper, its collection efficiency level high as 90% for particles from 0.23e-20 microns. This allows minimal corrections for colculations involving parmis. sible limits for hazardous:dusts

FLOW CONTROL

A unique feature of the sampler is the compact total mater built into the sample sallecter which is worth as the lapel or collar. This ellews constant seems in seems to of the flaw rate. The sampler can be assured constantly up to 10 hours larger before charge, charging becomes necessary. If one we worn for large periods of time without a change of filter paper, since the flow central can provide solvetness at flow when the filter paper starts to lead.

CHARGING SYSTEM

Charging the battery is accomplished by simply is: serting the retractable triple strip that it is self-line. The neon indicator leng signals that the self-contained charging system is in operation. A switch is incorporated for selection of daily or weekend charging.

*Collection Efficiency of Ale Cleaning one Air Sampling Filter Media, J. J. Fitzgerald and C. G. Detwiler

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WHERE SERVICE AND GOODW ...

August 21, 1961

A NEW CONCEPT

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Piltronius inc is proud of its spiroshidtion to the Industrial Hygiens field of the Filtronius Atsospheric Section Secretard by the attached literature. This compact first effective instrument has been so enthistastically received by users that we feel a continued obligation to let others know of its applications and attributes

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CONTINUOUS AIR MONITORS AT ORGOP

Monitor No.	Location	Division	Operator
1	K-301-3	Industrial Relations	A. F. Becher
2	K-301-3	Industrial Relations	A. F. Becher
3	K-1131 Tray Area	Production	T. Koprowski
4	K-1420 "B" Area	Chemical	J. Dykstra
5	K-1420 Large Equipment	Chemical	J. Dykstra
6	K-1401 Axial Flow Shop	Maintenance	E. C. Sternber
7	K-131 Maintenance Shop	Maintenance	W. H. Luckett
8	K-601 Building	Production	J. Arendt
9	K-1401 Building	Maintenance	H. O. Sternber
10	K-631 Building	Production	L. W. Anderson
11	K-1413 Building	Technical.	H. L. Kaufman
12	K-1420 H Area	Chemical	J. Dykstra
13	K-1131 Feed Preparation Area	Production	T. Koprowski
1 /4	K-1410 Soak Tank Room	Chemical	J. Dykstra
15	K-1131 Cold Trap Area	Production	T. Koprowski
16	K-33 Feed Room	Production	R. H. Dyer
17	K-305-9 P.W. Station	Production	B. II. Thompson
18	K-1420 "E" Area	Chemical	J. Dykstra
19	K-301-3 Building	Industrial Relations	A. F. Becher
20	K-301-3 Building	Industrial Relations	1. F. Becher

Safety and Health Physics Dept. Industrial Relations Division

December 7, 1961



INTERNAL CORRESPONDENCE -

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W. A. Pfeiler

Building 9215 .

Date

December 31, 1963

Company Location

Originating Dept.

2163

Answering letter date

Copy to

O. W. Briscoe

S. H. Cole

R. H. Kent

J. C. Thomason

R. G. McMillan (Y-12RC)

Subject

Uranium Analyses of Air

Samples on Four-Inch

Filter Papers

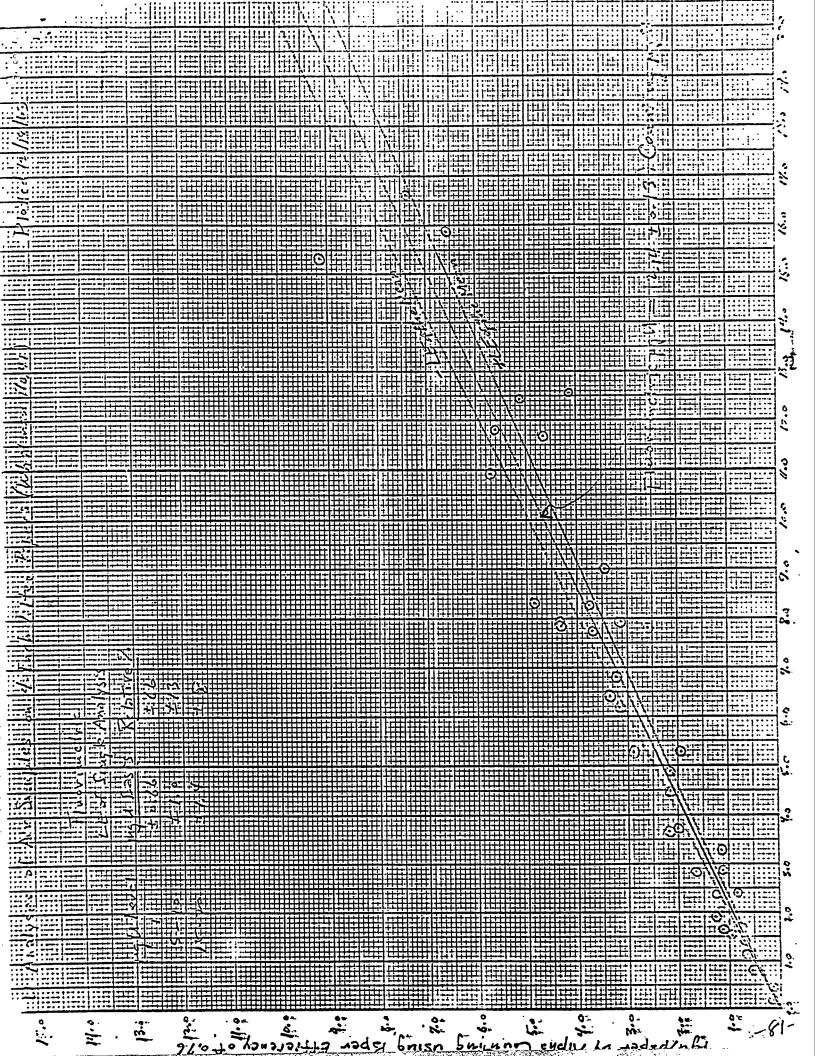
Fluorimetric uranium analyses of fifty routine air samples on four-inch filter papers (Whatman No. 41) have been compared with the uranium contents computed from alpha counting measurements using the current paper efficiency of 0.76. This comparison shows that the fluorimetric results averaged 2.14 ±0.13 times higher than the counting results based on the 0.76 paper factor. The attached graph presents a summary of the results.

E. E. Johnson

EEJ:jc

Attachment

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DISTRIBUTION

- 1. K-25 Site Records (RC)
- 2. ChemRisk/Shonka Research Associates
- 3. DOE Public Reading Room
- 4. S. G. Thornton (K-25 EMD)